

INTEGRATED OCCUPATIONAL PROGRAM

Program of Studies/Curriculum Guide

MATHEMATICS 26

INTERIM - 1991

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ADDENDUM

Addendum to Integrated Occupational Program Program of Studies/Curriculum Guides 26-Level Courses

COMMUNITY PARTNERSHIPS

School administrators and teachers are advised that the **APPLICATION FOR APPROVAL OF WORK SITES/STATIONS** (Parts A and B) must be completed for each work site/station at which an Integrated Occupational Program (IOP) student is placed.

In addition, each student involved in any off-campus IOP learning activity must be registered by the school/school jurisdiction as being placed in an approved work site/station.

Specific procedures and legislation about work experience (community partnerships) is provided in the following documents:

Alberta Education Program Policy Manual

(Available upon written request from Central Support Services,
11160 Jasper Avenue, Edmonton, Alberta, T5K 0L2.)

Work Experience Program: Teacher Resource Manual Junior and Senior High School,
Alberta Education, 1990

(Available from the Learning Resources Distributing Centre,
12360-142 Street, Edmonton, Alberta, T5L 4X9.)



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Mathematics 26
Program of Studies/Curriculum Guide

Grade 11

INTERIM – 1991

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NOTE

CURRICULAR DOCUMENT FORMAT

To provide educators with a comprehensive overview of the Integrated Occupational Program, all IOP curricular documents have adopted the format of combining the Program of Studies and Curriculum Guide into one document. The shaded statements or segments within this document indicate the prescriptive contents of the Program of Studies. All other advice and direction provided are suggested only.

The terminology and format used in this document reflects policy in effect when IOP curriculum development began in 1987.

METRICATION POLICY

It is the policy of Alberta Education that "SI units become the principal system of measurement in the curriculum of the schools in the province". In preparing students for transition to the workplace where imperial/U.S. measurements may still be in use, both SI metric and other units of measurement are addressed in the practical arts/occupational component of the Integrated Occupational Program.

The comparison/teaching of metric units with other units of measurement should be restricted to those that are relevant to student needs as reflected by common usage in course-related workplaces.

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RATIONALE

The Integrated Occupational Program (IOP), developed as an outcome of the *Secondary Education in Alberta* (June 1985) Policy Statement, is a program for students who have experienced difficulty in learning. The program consists of both core and complementary courses designed to develop concepts, skills and attitudes necessary for everyday living. The Policy Statement says that a Certificate of Achievement will be awarded to those students who, because of their abilities and needs, have taken the Integrated Occupational Program. The certificate will recognize their achievement in the program.

The Integrated Occupational Mathematics Program provides a two-course sequence in mathematics known as Mathematics 16-26. Mathematics 16 allows students to meet the credit requirements of the Certificate of Achievement. Mathematics 26 allows students to develop their knowledge and skills in mathematics more fully, and facilitates transfer to the General High School Diploma Program.

The Mathematics 16-26 program provides for the development of essential concepts, skills and attitudes required for effective computation and problem solving. The program is activity-based, and addresses the need for students to be able to transfer and apply specific mathematical concepts and skills to more generalized situations in everyday life and the world of work. The program is intended to foster an appreciation of mathematics for its usefulness and relevance, and thus motivate students to participate in the learning process.

Today's world demands that students are able to cope with the rapid pace at which change occurs in both home and work environments. A focus on effective strategies for problem solving will assist students to develop appropriate thinking skills and the ability to solve problems and make decisions in new and unfamiliar situations. Students also need to understand applications of calculators and computer technologies in everyday situations involving computation and problem solving. Time spent learning mathematics can no longer be limited to practising long, repetitive or tedious procedures that are more efficiently accomplished with a calculator. A focus on the use of technology throughout the mathematics program will enable students to develop the ability to use calculators and computers in performing routine tasks more easily replicated by these technologies. The demands of daily living require ability to perform computation using several different methods, including mental arithmetic, estimation, the calculator and paper/pencil. A focus on computational facility and estimation skills will assist students to select and use computational procedures that are appropriate in a variety of practical situations.

Students are often unaware of strategies they may generate and employ to become more efficient in their cognitive functioning. Evidence supports, however, that students with learning difficulties can perform strategically if taught to do so. Thinking strategies that foster effective behaviours in planning, organizing and self-monitoring are emphasized throughout the program. As students learn to understand and control the outcome of tasks demanded of them, confidence in taking risks and accepting challenges will further their ability to solve problems and make informed decisions in everyday life.

Prescribed content within Mathematics 16 and 26 reflects an emphasis on life skills, and has been determined on the basis of the abilities and needs of students for whom the courses were designed. Nevertheless, the philosophy, goals and directions established in the Integrated Occupational Mathematics Program are consistent with those of other regular program mathematics courses. This continuity will assist students in their transition from regular program courses into the IOP, and will also facilitate potential transfer of some students from the Mathematics 16-26 program back into regular program mathematics courses.

PHILOSOPHY

The Integrated Occupational Mathematics Program focuses first and foremost on the needs of the learner. As attitude and self-esteem are powerful influences over learning, the program must foster in each student a positive self-concept and a positive attitude toward learning. The concepts, skills and attitudes addressed within the program must:

- provide meaningful and relevant experiences
- be appropriate to student ability
- provide for student success.

Students vary in the way they receive, process, recall, apply and communicate information. Each student has a preferred way of approaching learning tasks. Instructional planning must include careful assessment of each student's developmental characteristics, knowledge, skills and preferred way of learning. In order to ensure that individual student needs are being met, instructional plans may often need to be adjusted or modified.

An integrated approach suggests the linking together of various mathematical skills and strategies into meaningful activities and applications. Abstract concepts and ideas will take on new meaning and significance to students when applied to daily experiences. Organization of mathematics instruction into "themes" is intended to advance the notion of "holistic" learning, relative to both mathematics and the student. Discrete skill instruction is appropriate when specific deficiencies are noted.

Although students are at various stages of cognitive development, most will continue to use concrete operational thinking. Students will depend on personal experience and personalized content to link new ideas with prior knowledge. As the process of analysis must be based on tangible experience, learning activities should begin at the concrete level. High emphasis should be placed on experiential learning involving manipulatives and hands-on activities. Specific skills and concepts should be developed after establishing a need for their use through learning activities involving three levels of instructional technique:

- concrete (e.g., use of models)
- transitional (e.g., pictorial representation)
- formal (e.g., symbolic representation).

Direct assistance must be provided to the learner in progressing from the concrete level of thinking to the more abstract thought processes. Appropriate strategies for providing this assistance have been included in this *Program of Studies/Curriculum Guide* and the corresponding *Teacher Resource Manual*.

The mathematics program must address the realities of today's society in developing the concepts, skills and attitudes that students will use in everyday life and in the world of work. The demands of daily living suggest the program place increased emphasis on the:

- development of number sense and computational facility
- use of technologies such as the calculator and computer
- application of what is learned to a variety of problem-solving situations within a changing society.

These learning goals suggest a broader context for instruction in mathematics, and provide a focus for learning activities that are suggested throughout the program.

GOALS OF THE MATHEMATICS 16-26 PROGRAM

The Integrated Occupational Mathematics Program is designed to assist students in developing and maintaining:

- positive and realistic self-images
- constructive relationships with others
- positive attitudes toward mathematics and lifelong learning.

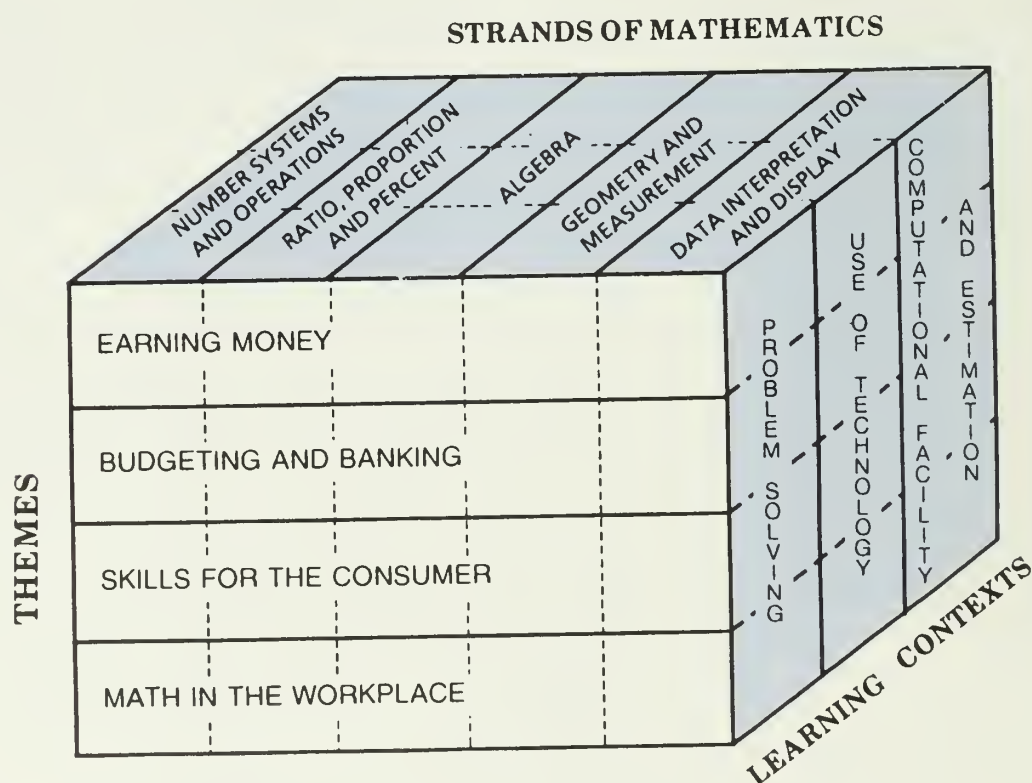
Within the Mathematics 16-26 program, students will be expected to:

- develop the essential concepts, skills and attitudes of mathematics that are required for responsible participation in the home, the school, the community and the workplace
- apply mathematical concepts and skills to daily life and occupational situations that are experienced both inside and outside the mathematics classroom
- develop critical and creative thinking skills, and apply these skills through a problem-solving process to a variety of practical situations
- develop the ability to use technology in its various forms
- develop communication skills that are used when learning mathematics and solving practical problems.

MODEL FOR THE MATHEMATICS PROGRAM

The model for the Integrated Occupational Mathematics Program illustrates an integration of program dimensions. Three dimensions that provide a basis for program planning are represented in the model. Prescribed components within the mathematics program are shaded.

- The **STRANDS OF MATHEMATICS**, represented on the upper face of the model, include concepts, skills and attitudes related to five major content areas. Prescribed content within each of the strands has been determined on the basis of frequent task demands placed upon students in everyday life, and is outlined in the Scope and Sequence (pp. 37-42) and Program of Studies/Presentation of Content (pp. 59-91).
- The **LEARNING CONTEXTS**, represented on the right face of the model, focus attention on strategic behaviours that will enable students to solve problems, use technology and perform computations in daily living. Prescribed concepts, skills and attitudes related to each of the learning contexts is outlined in the Scope and Sequence (pp. 34-36) and Program of Studies/Presentation of Content (pp. 45-57).
- The **THEMES** provide situational and concrete learning experiences where concepts, skills and attitudes related to each of the strands and learning contexts are linked together. Four themes that address prescribed components within the mathematics program are provided in the *Teacher Resource Manual* (available from the Learning Resources Distributing Centre, see p. 11). The themes are placed on the front face of the model to highlight their importance in planning an integrated program.



STRANDS OF MATHEMATICS

The strands provide a structure for organizing prescribed concepts, skills and attitudes within each of five content areas (i.e., number systems and operations, ratio/proportion and percent, algebra, geometry and measurement, data interpretation and display). Content within each strand represents a consolidation and extension of concepts, skills and attitudes included in the Integrated Occupation Mathematics Programs for Grades 8 and 9.

This dimension of the program highlights the developmental nature of mathematical competencies, and promotes a diagnostic approach through the explicit identification and sequencing of prescribed concepts and skills within each strand. Learning deficits can be determined and activities planned that will enable individual students to progress from their current to a higher level of functioning.

LEARNING CONTEXTS

The learning contexts provide for an element in teaching and learning that transcends and permeates all that is done within the mathematics program. This dimension fosters the development of concepts, skills and attitudes that enable students to interpret, process and apply information in their environment relative to the demands of daily living. Learning activities that focus attention on developing effective strategies for solving problems, using technology and performing computation/estimation are provided throughout each theme in concert with activities designed to develop concepts and skills within each of the strands of mathematics.

Demands of a changing society make it increasingly important that students develop appropriate strategies for solving problems and making informed decisions in a variety of everyday situations. Educational research strongly supports the teaching practice of modelling appropriate thought processes, discussing those processes the students presently use, and encouraging students to develop additional strategies. These techniques are beneficial as students may not spontaneously generate their own learning strategies, and may remember and use teacher taught strategies more often than those acquired incidentally.

THEMES

The themes provide the settings and the tasks where concepts, skills and attitudes are linked together in meaningful investigations. These investigations focus attention on a particular topic or concern, and provide students with practical experiences related to real problems and/or issues affecting their lives.

Using themes facilitates learning in a way quite different from the "skills-based" approach favoured by many conventional curricula. For example, a skills-based unit on "Decimals" may focus instruction entirely on a particular set of skills within one strand (e.g., operations with decimals). In contrast, a thematic unit on "Skills for the Consumer" will include the use of skills from a variety of strands (e.g., decimals, measurement, ratio).

In addition to providing for the natural integration of a variety of concepts, skills and attitudes, a well-constructed theme allows for activities in all levels of thinking (i.e., recall, application, analysis, synthesis and evaluation). Other advantages of thematic planning and organization of prescribed content include:

- provision for cumulative development of background knowledge and skill, enabling students to relate and transfer learning from one day to the next
- opportunity to remediate/reinforce skills already taught in new situations, thus avoiding repetitious drill and promoting transfer of the skills to many areas
- flexibility in responding to student interests and needs. Learning will be facilitated when students see activities as being worthwhile and meaningful
- opportunity to use a wide variety of activities, media and resources
- opportunity to develop strategies and skills in problem solving and decision making through investigations that reflect real issues and problems present in the local community.

While a thematic approach is suggested for the Mathematics 16-26 program, skills-based lessons or units should be provided when specific deficiencies are noted. For example, the need to develop and refine estimation skills may become obvious as students perform computations within a particular theme. Instruction and practice in estimating might then be provided through a separate sub-unit that focuses entirely on developing estimation strategies. Teachers are encouraged to determine which skills should be removed from the thematic context and taught or reinforced in a more focused manner.

Four themes that assure coverage of the prescribed content within Mathematics 16 and Mathematics 26 have been provided in the *Teacher Resource Manual*. The chart below indicates the nature of investigations within themes developed at each grade level.

	MATHEMATICS 16	MATHEMATICS 26
Theme A EARNING MONEY	● FINDING EMPLOYMENT ● COMPUTING INCOME	● PAYING TAXES ● BUYING AND SELLING
Theme B BUDGETING AND BANKING	● USING BANK ACCOUNTS ● PREPARING BUDGETS	● USING CREDIT ● SAVING AND INVESTING
Theme C SKILLS FOR THE CONSUMER	● BUYING GOODS AND SERVICES ● OPERATING A VEHICLE	● ESTABLISHING A PLACE OF YOUR OWN ● BUYING A VEHICLE
Theme D MATH IN THE WORKPLACE	● ESTIMATING AND MEASURING ● USING SCALE DRAWINGS AND MODELS	● DESIGNING AND BUILDING ● MONITORING INVENTORY AND CASH FLOW

At the local level, teachers may wish to develop additional or alternative themes in order to reinforce and expand upon prescribed concepts, skills and attitudes.

INTERPERSONAL SKILLS AND THE SOCIAL SPHERE

High school represents a transitional stage of life for students as they develop the ability to use adult skills. For some students it may be a time of uncertainty as they strive for independence, yet at the same time experience pressures from parents, peers, media and themselves. Response to these pressures may be inconsistent as students continue to develop reflective awareness and the ability to analyze their emotions.

Although schools are not the sole influences on the student's emotional, social and ethical behaviour, the instructional program does affect interpersonal learning.

The Goals of Secondary Education directly state the importance of affective and interpersonal goals when they indicate that students should:

- learn about themselves and develop positive, realistic self-images
- develop constructive relationships with others based on respect, trust, cooperation, consideration and caring as one aspect of moral and ethical behaviour.

Students will vary in their emotional/social development and their ability to cope with personal problems. Behaviours viewed as "problematic" are often simply an indication of a student's lack of sophistication in using adult skills. Classroom instruction must provide a variety of approaches that will encourage students to reflect upon their responses in social situations and to develop productive interpersonal skills. The guidelines that follow have been adapted from Alberta Education's monograph *Students' Interactions, Developmental Framework: Social Sphere* (1988), and are intended to foster affective, interpersonal and moral learning within the classroom:

- Students imitate and thereby implicitly learn to deal with emotions, other people and ethical issues by observing the consistency of adult behaviour. Therefore, it is important that appropriate behaviour be modelled for students. When teachers are respectful of students' dignity, students will respond positively.
- Encourage students to express their opinions and feelings, to ask questions and to accept emotions as they occur in day-to-day life. Through mediated learning (see "Instructional Mediation"), encourage students to examine emotional responses from different frames of reference, and to organize and interpret their own responses as well as the responses of others.
- Provide students with supportive comments, guidance and genuine expressions of concern. Set expectations that are firm and fair, and then believe in the students' ability to meet these expectations and do well. Develop "working agreements" to help tasks flow smoothly, and to ensure that students understand the nature of the instructional tasks they are asked to perform.
- Ensure that classroom management practices and rules are known, upheld, moderate in nature, negotiable, and consistently applied. Responding to the harmful or unjust effects/consequences of a moral transgression is more effective than reference to broken rules or unfulfilled social conventions.
- Recognize that experiential learning is a particularly effective vehicle for teaching interpersonal skills. Although some learning may occur through listening and reading, one best learns to live with other people by living with other people. Cooperative learning techniques are especially useful where students are actively involved in lessons linked to their own needs, interests or experiences.

- Be aware that although teenagers deal with a number of issues, these issues usually come into focus at different times. The issues are not so interdependent that the solution of one of them requires prior solution of others. Help students to integrate various aspects of their lives by encouraging them to recognize how various problems/issues/solutions are often interrelated.
- Assist students to learn skills that are appropriate in differing contexts. Although some students are described as "lacking in social skills", socially maladapted students do not necessarily lack either skills or social involvement; rather, they use inappropriate skills in particular contexts. When directly teaching interpersonal skills, be as concrete as possible, and "build bridges" by linking situations with appropriate actions and behaviours.
- Assist students to focus on the need for a system of shared conventions. As students affirm the social system of conventions, they will view conventions more positively and will become less disruptive in their behaviour.
- Encourage students to interpret and evaluate ethical issues presented to them. Provide opportunities for open discussion and debate, where students interact with their peers. Discuss issues that are "real" to the student.
- Provide students with practical strategies for resolving interpersonal conflict. A framework for social problem solving is provided in the *Teacher Resource Manual*. This framework uses a problem-solving approach in helping students to identify:
 - reasons for the difficulty
 - strategies to avoid the conflict another time.

Student development in the affective and interpersonal domains has been addressed in this curriculum through attitudinal learning objectives that accompany each cluster of concepts and skills in the Program of Studies. Instruction must nurture the development of these attitudes through a variety of approaches appropriate to student interest and maturation. The *Teacher Resource Manual* provides suggestions for developing prescribed attitudes within the context of themes outlined for this program.

REQUIRED AND ELECTIVE COMPONENTS

The required component of the Mathematics 16-26 program includes the concepts, skills and attitudes that all students must acquire. Shaded statements within the Program of Studies/ Presentation of Content section of this document (pp. 43-91) outline the required component of the program.

In keeping with the philosophy that concepts, skills and attitudes are more successfully learned if taught within relevant contexts, they are integrated into four themes at each grade level:

- Earning Money
- Budgeting and Banking
- Skills for the Consumer
- Math in the Workplace.

These themes are developed in the *Teacher Resource Manual*, and include a variety of student activities intended to provide suggestions, models and strategies. Although using these themes will ensure coverage of the required component, teachers are encouraged to add, delete and alter activities to comply with the abilities, needs and interests of students. The Planning section of this document provides general guidelines and ideas for adapting a theme to the particular circumstances of the classroom and individual students.

The elective component of the Mathematics 16-26 program permits the teacher to:

- **remediate or reinforce** concepts, skills and attitudes within the required component
- **extend or enrich** the program by introducing additional concepts, skills and attitudes considered appropriate to student interest and needs.

Students' abilities, interests and needs will largely determine how the elective time will be used. The elective component provides opportunities for varying organizational and instructional strategies that facilitate learning and that are appropriate to each student's developmental stage and preferred way of learning.

Instructional time for the Mathematics 16-26 program should be apportioned:

- 80% Required
- 20% Elective.

OVERVIEW OF THEMES COVERING THE REQUIRED COMPONENT

The required components of Mathematics 16 and Mathematics 26 have been integrated into thematic units of instruction provided in the *Teacher Resource Manual*. These thematic units address prescribed content within the "learning contexts" established for the mathematics program (i.e., problem solving, use of technology, computational facility and estimation) and the "strands of mathematics" (i.e., number systems and operations; ratio, proportion and percent; algebra; geometry and measurement; data interpretation and display).

Although the thematic approach provides for the integration of a variety of concepts, skills and attitudes, themes vary in the degree to which they lend themselves to the use of prescribed content within particular strands. The matrix indicates the strands that are a focus of development throughout each theme.

	Number Systems and Operations	Ratio, Proportion and Percent	Algebra	Geometry and Measurement	Data Interpretation and Display
EARNING MONEY	X	X	X		X
BUDGETING AND BANKING	X	X	X		X
SKILLS FOR THE CONSUMER	X	X	X	X	X
MATH IN THE WORKPLACE		X	X	X	X

SUGGESTIONS FOR THE ELECTIVE COMPONENT

Several factors should be considered in choosing content for the elective component:

- student abilities/interests/needs
- curriculum objectives
- availability of suitable learning resources.

For some students, the elective component may be used to provide additional instructional time for study of the themes that support the required component of the program (i.e., extension and remediation). In other instances, however, teachers may wish to develop enrichment themes using the elective component of the program. Themes of this nature might relate to:

- mathematical competencies required in occupational courses
- a life experience or student interest topic
- a mathematical skills unit.

Teachers are encouraged to refer to the Planning section of this document when developing thematic units.

LEARNING RESOURCES FOR MATHEMATICS 16-26

STUDENT RESOURCES

BASIC LEARNING RESOURCE

The learning resource listed below addresses the majority of the goals and learning objectives identified in this *Program of Studies/Curriculum Guide*.

Carli, Enzo, et al. *Consumer and Career Mathematics*. Second Canadian edition. Agincourt, Ontario: Gage Educational Publishing Company, 1991.

SUPPORT LEARNING RESOURCES

The learning resources listed below assists in addressing some of the learning objectives identified in this *Program of Studies/Curriculum Guide*. Multiple copies (but not necessarily class sets) may be desired.

Cutting, Robert, et al. *Math You Need, Book 2*. Scarborough, Ontario: Nelson Canada, A Division of Thomson Canada Limited, 1982.

Lunney, Jeri, et al. *MathSense, Book 2*. Scarborough, Ontario: Nelson Canada, A Division of Thomson Canada Limited, 1991.

OTHER LEARNING RESOURCES

A listing of other learning resources potentially useful in implementing the Mathematics 16-26 program, but which have not undergone the standard review procedures of Alberta Education is provided in the *Teacher Resource Manual*. The responsibility for evaluating these resources prior to selection and use rests with the local jurisdiction according to local policy.

TEACHER RESOURCES

The teacher support publication listed below (and available through the Learning Resources Distributing Centre, 12360 – 142 Street, Edmonton, Alberta, T5L 4X9. Tel: 427-2767) is designed to assist classroom teachers to implement the Integrated Occupational Mathematics 26 Program. The publication provides teaching strategies and sample activities that structure the development of concepts, skills and attitudes as outlined in the Program of Studies, and supports thematic instruction in four areas described as covering the required component of the program.

Alberta Education. *Mathematics 26 Teacher Resource Manual*. Edmonton, Alberta: Alberta Education, 1990.

Other teacher resources that address major goals and learning objectives identified in this *Program of Studies/Curriculum Guide* (and available through the Learning Resources Distributing Centre) include:

Charles, R., et al. *How to Evaluate Progress in Problem Solving*. Reston, Virginia: The National Council of Teachers of Mathematics, 1987.

National Council of Teachers of Mathematics. *Curriculum and Evaluation Standards for School Mathematics*. Reston, Virginia: The National Council of Teachers of Mathematics, 1989.

A listing of additional teacher resources potentially useful in implementing the Mathematics 16-26 program are identified in the *Teacher Resource Manual*.

TECHNOLOGY AND MEDIA

SUPPORT LEARNING RESOURCES

The computer software programs listed below assist in addressing some of the learning objectives identified in this *Program of Studies/Curriculum Guide*.

- | | |
|-------------|---|
| Title: | <i>Math Strategies: Problem Solving</i> |
| By: | Science Research Associated (Canada) Ltd.
707 Gordon Baker Road
Willowdale, Ontario
M2H 2S6 |
| Components: | 2 disks, teacher's guide (28 pp.), 20 student texts (108 pp.) |
| Objectives: | This program is designed to provide instruction and practice in solving multiple-step problems using four problem-solving strategies: simplifying a problem, breaking a problem into parts, identifying needed additional information, and making a model of the problem. |
| | |
| Title: | <i>Money Manager</i> |
| By: | Computer Age Education Inc.
52256 Wisconsin Avenue N.W., Suite 601
Washington, D.C.
20015 |
| Components: | 1 disk, teacher's guide (11 pp.), user's guide (4 pp.) |
| Objectives: | This program is a simulation designed to help the student develop and practise skills in financial management. The goal is to earn the most financial points possible over a simulated eight-week period. |

An annotated list of additional computer software approved for regular secondary mathematics programs and which may be useful in Mathematics 16-26 is provided in Alberta Education's catalogue of *Computer Courseware Evaluations* (1986) and annual supplements.

OTHER LEARNING RESOURCES

A listing of other technology and media resources (e.g., films, videos, software, kits, pamphlets) potentially useful in implementing the Mathematics 16-26 program, but which have not undergone the standard review procedures of Alberta Education is provided in the *Teacher Resource Manual*. The responsibility for evaluating these resources prior to their selection and use rests with the local jurisdiction according to local policy.

ACCESS NETWORK

ACCESS offers a variety of resources and services to teachers. For a nominal dubbing and tape fee, teachers may obtain copies of educational programs directly from ACCESS NETWORK. ACCESS also offers a service called "Night Owl Dubbing". This allows educators to tape selected educational programs directly from their own televisions.

ACCESS publishes both an *Audio-Visual Catalogue* and a comprehensive schedule of programming, available on request.

For additional information, contact ACCESS NETWORK, Media Resource Centre, 295 Midpark Way S.E., Calgary, Alberta, T2X 2A8 (from outside of Calgary, telephone toll free, 1-800-352-8293; in Calgary, telephone 256-1100).

REGIONAL AND URBAN RESOURCE CENTRES

There are a number of resource/media centres serving the needs of teachers within different geographical areas and jurisdictions across Alberta. Each centre carries audio and visual resources, and publishes its own catalogue listing the resources in its collection. These centres operate as libraries, and lend materials for specified time periods.

A complete list of regional and urban resource centres, addresses and telephone numbers is provided in the *Teacher Resource Manual*.

PLANNING

GENERAL COURSE PLANNING

Themes and their related concepts, skills and attitudes may be sequenced at the teacher's discretion. Course planning should take into consideration the sequential and developmental nature of learning in mathematics as well as students' interests, abilities, and preferred ways of approaching tasks. The four themes developed in the *Teacher Resource Manual* are intended to be descriptive rather than prescriptive. Teachers may choose to modify these themes or replace them with other locally developed material in addressing individual student needs.

Through cooperative conferencing, teachers may find that students are required to use certain mathematics-related competencies in other courses before they are learned in mathematics class. Joint planning and negotiation with teachers of other courses will assist in establishing an integrated program that places consistent expectations upon the student. (For example, students may benefit from study of the theme "Math in the Workplace" early in the course as this theme addresses the skills frequently demanded of students in their occupational courses.)

Course planning should also focus attention on effective strategies for solving problems, using technology (e.g., the calculator and computer) and performing computation/estimation in practical situations. The strategies and activities suggested throughout both the *Program of Studies/Curriculum Guide* and *Teacher Resource Manual* are numerous, but by no means exhaustive. **Be prepared to add, delete, and modify activities in adapting instructional materials and methodology to the particular circumstances of the classroom and student.**

TIME ALLOCATION

Mathematics 16 and 26 are each 3-credit courses. Instructional time for each course is to be allocated at the discretion of the school or jurisdiction administration to reflect the needs of individual students.

The chart below suggests time distribution among themes developed in the *Teacher Resource Manual*. These suggestions are intended to provide guidance for the teacher.

THEME	ELECTIVE COMPONENT	SUGGESTED TIME ALLOCATION
EARNING MONEY	RE ME DI A T I O N A N D / O R E N R I C H M E N T	$\frac{1}{4}$
BUDGETING AND BANKING		$\frac{1}{4}$
SKILLS FOR THE CONSUMER		$\frac{1}{4}$
MATH IN THE WORKPLACE		$\frac{1}{4}$

COMMUNITY PARTNERSHIPS

The mathematics program must enable students to recognize the relevance of computational competence and problem-solving skills in daily life experiences within the home, community and work environments. Within this context, students will be expected to demonstrate competencies that will enable them to:

- apply mathematical concepts and skills to practical situations
- set goals, solve problems and make informed decisions
- prepare for a chosen occupation or career.

Community partnerships (i.e., community-based learning experiences) will foster an appreciation of mathematics for its usefulness and relevance. Community involvement will assist students to transfer specific mathematical concepts and skills to more generalized situations in everyday life and the world of work. Guest speakers, field trips, job shadowing and mentorship are a few examples of meaningful community associations.

Suggestions for relevant community partnerships in the mathematics program include:

- inviting guest speakers from local government, business and industry to discuss topics related to those studied in thematic investigations
- visiting local business, industry, and recreational facilities for first-hand observation and "real life" experience in areas related to the themes studied
- walking through the community in search of applications made of the concepts and skills being studied (e.g., advertising billboards, information/direction signs, tools/units of measure, presence of geometric form)
- visiting local TV stations or newspaper plants in order to gather information related to mathematics and the media
- investigating career and employment opportunities in areas that require specific mathematical competencies (e.g., job shadowing, mock employment interviews).

Community agencies and groups that may provide meaningful contributions to the mathematics program include:

- businesses involved in retail sales and the promotion of consumer products/services (e.g., supermarkets, drug stores, department stores, hardware stores)
- financial institutions (e.g., banks, credit unions, loan companies)
- government agencies (e.g., Consumer and Corporate Affairs, Labour and Employment Standards, Career Development and Employment, Revenue Canada, Unemployment Insurance Commission, Workers' Compensation Board)
- businesses and industries offering potential career opportunities (e.g., construction, decorating and repair service, retail sales and marketing, food production and service).

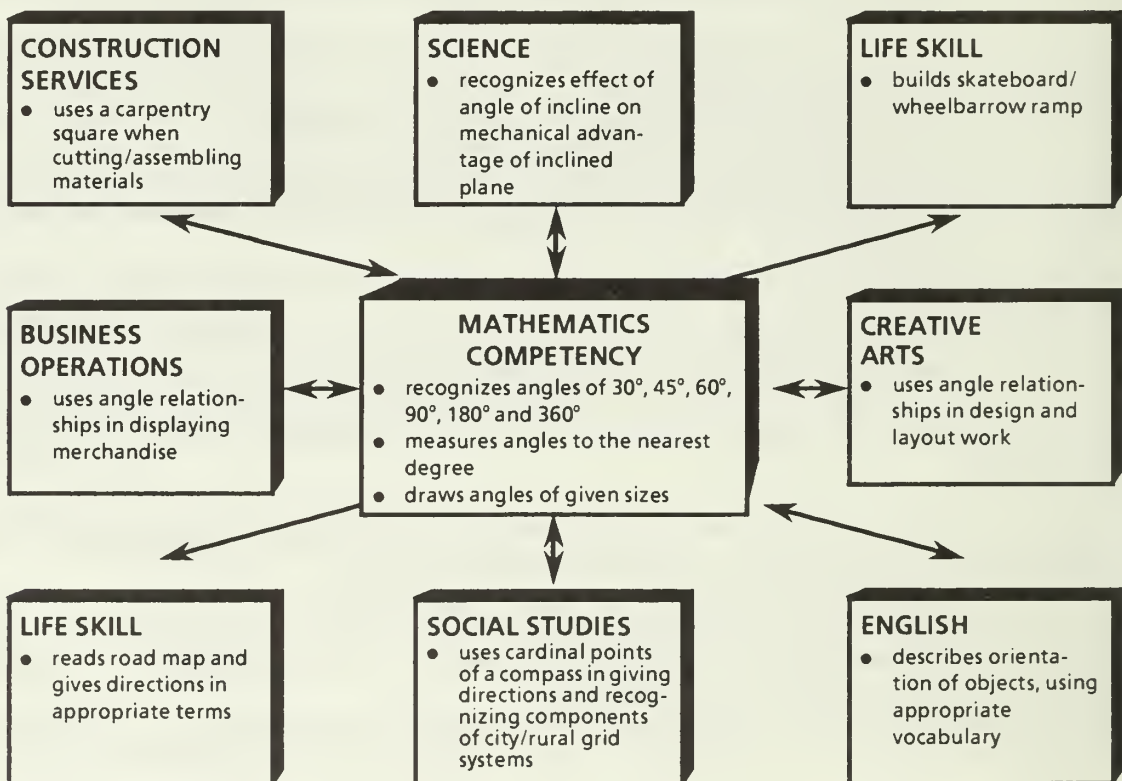
Additional suggestions for inviting members of the community into the classroom, or having students involved in the community by way of meaningful activity linked to mathematics are provided within the *Teacher Resource Manual*. These suggestions may be effective in furthering the objectives of each theme, as well as in reducing classroom barriers to "real life" experience.

CURRICULAR INTEGRATION

The mathematics program relates mathematical competencies to life skills and to other subject areas across the curriculum. Course content is presented within the context of its application in daily living, the occupational program and other academic disciplines. Curricular integration will become a motivating factor as students recognize the relevance and utility of course content. Student ability to transfer concepts, skills and attitudes to a variety of situations in everyday life and the world of work will improve as a result of contextualized learning experiences that link prescribed content with "real life" applications.

Teachers need to be familiar with the mathematical competencies required of students in everyday life, the occupational program and other academic disciplines. Cooperative planning and conferencing with other teachers is central to understanding differing contexts in which basic mathematical skills are used, and will assist teachers in providing practical learning experiences that encourage transfer of knowledge and skill.

EXAMPLES OF CURRICULAR INTEGRATION BASED ON THE MATHEMATICAL COMPETENCY OF ANGLE MEASUREMENT



Angle concepts and skills are developed in mathematics and related to their applications in other areas. While in this instance application is shown in all subject areas, some skills may have a more limited base for application.

The Program of Studies/Presentation of Content section of this document (pp. 43-91) provides suggestions for relating prescribed content to daily life skills (Column 2) and to its applications in other subject areas across the curriculum (Column 3). The *Teacher Resource Manual* provides additional suggestions and approaches for linking prescribed content with practical applications.

PLANNING AN INTEGRATED UNIT OF INSTRUCTION

Teachers are encouraged to consider a variety of factors when expanding upon an existing theme or developing a new thematic unit. The guidelines that follow provide a useful structure for developing integrated units of instruction.

1. Identify a possible theme, based on:

- curriculum objectives
- student needs/interests/abilities
- availability of suitable learning resources.

2. Develop a purpose for the theme. Include:

- appropriate thematic objectives
- a checklist of concepts, skills and attitudes that lend themselves to the theme. Identify those skills that may need some focused/direct teaching.

3. Consider suitable resources:

- books, pamphlets, monographs
- computer software and other technology
- resources from the occupational program
- community contacts
- newspaper and magazine articles
- other resources to which students may have access.

4. Design activities:

- allocate activities to the purposes developed in Step 2
- develop a checklist of process objectives
- separate activities into lessons with general and specific objectives
- sequence the lessons.

5. Develop ongoing strategies to build community partnerships into your theme:

- field trips
- guest speakers.

6. Plan for evaluation:

- students' self-evaluations
- teacher's ongoing (formative) and summative evaluations
- peer evaluations.

7. Share the unit:

- celebrate achievement
- share thematic units with other teachers
- expand, update and revise units as they are used
- develop strategies to evaluate the updated and revised activities with a variety of student groups.

METHODOLOGY

OVERCOMING MATHEMATICS ANXIETY

Anxiety about mathematics may represent a major barrier to learning for many students. Previous experiences, perceptions of the value of mathematics, and the fear of being wrong or making a mistake are all factors that may cause the student to look upon mathematics class as a place where personal inabilities are exposed. To assist students in dealing with their anxieties, a supportive environment should be provided where meaningful learning activities ensure that each student experiences success. The program must be varied in materials, content and instructional method in order to meet individual student interests and abilities.

The suggestions that follow will assist in establishing a supportive classroom environment that decreases anxiety levels and ensures student success.

- Begin instruction well below the "frustration" level. Providing "warm-up" activities enables the anxious learner to build on previous success. Learning activities should correspond to the student's current operational level rather than the level at which one might suppose the student should be working.
- Relate mathematical concepts and skills to the learner's own experiences. Ensure that the terminology used is part of the student's working vocabulary. Focus attention on what students consider interesting or important. Familiar problem situations will "make sense" to the student more readily than unfamiliar situations.
- Avoid unnecessary tension in the classroom by being patient, receptive and understanding. Ensure that students recognize that making a mistake is acceptable, and that such occurrences provide valuable learning experiences. Urge students to ask questions, and to accept that "there is no such thing as a stupid question". Remember that an offhand remark about a problem being "easy" may be interpreted by the student as "if it's easy and I'm confused, then I must be stupid". Recognize and accept alternative solutions that students may devise.
- Provide abundant opportunities for learning at the concrete level. Tactile experiences with base-ten blocks, geoboards, fraction pieces and cuisenaire rods will assist concept formation and application to problem situations. Encourage students to verbalize and discuss relationships discovered. Assist students to translate relationships discovered in the concrete to the abstract symbols used in mathematics.
- Match the reading level of resources and materials used to that of the students. Steps should be taken to ensure that reading deficiencies do not prevent students from learning mathematics (see Language Development in Mathematics, pp. 27-28).
- Group for instruction through a variety of organizational patterns that will facilitate meeting the needs of individual students. Ensure that grouping patterns remain flexible, allowing student movement from group to group. Include some learning activities that involve the whole group, small groups, and one-to-one situations (teacher to student and/or student to student).

- Use a variety of assessment and evaluation strategies. While paper-and-pencil tests are an effective way of evaluating some learning outcomes, their use does not always enable students to demonstrate their strengths and provide for successful experiences. In such cases, provide students with opportunities for retesting if necessary. Effective evaluation should draw upon information gathered from a number of sources, including teacher observation, student demonstration and project work. Additional strategies for student evaluation are provided in Evaluation (see pp. 31-32).
- Recognize that while most anxiety symptoms are brought on by natural apprehension associated with new or challenging situations, there are other displays of anxiety that may well be related to deeper personal or social problems. Personal interviews with students may assist in identifying such instances, and may also establish a need for consultation (or referral) with counsellors who have expertise in dealing with such problems.

EXPERIENTIAL APPROACHES TO MATHEMATICS

Student learning styles and developmental levels suggest a multisensory approach to learning within the ever expanding contexts of home, school, community and workplace. Learning activities need to be relevant to both student experience and daily living, and should provide abundant opportunities for "doing math" in practical situations. Instructional materials and methodology used throughout the program should:

- foster active student involvement
- address individual developmental levels
- involve concrete, transitional and formal levels of cognition
- promote the development of thinking skills through deliberate observation and questioning.

Themes outlined in the *Teacher Resource Manual* provide opportunities for students to develop an understanding of prescribed content through situational and concrete learning experiences. The numerous activities suggested throughout each theme are heavily contextualized, and encourage students to link concepts, skills and attitudes with a variety of "real life" applications.

Suggestions for incorporating manipulative and pictorial materials into teaching and learning activities are provided throughout both this document and the *Teacher Resource Manual*. **Even at the high school level, students need to have direct access to the use of manipulatives in order to internalize new concepts.** Cautionary notes have been provided where it is anticipated there may be a lack of congruence between cognitive demands of the curriculum and the developmental level of students (e.g., fractions, ratio, percent, two- and three-dimensional geometry). In these instances, the use of manipulative and pictorial materials becomes increasingly important in planning learning activities that are developmentally appropriate.

While the purpose of concrete and transitional learning strategies is to help students understand and remember, there comes a time when students should become efficient in making application of concepts in their abstract form. It is important, therefore, to supplement and alternate the use of manipulative and pictorial materials with other more formal learning strategies. Encourage students to observe, verbalize, discuss and ask questions about the relationships they investigate through concrete and transitional methods, and eventually to translate these relationships into the abstract symbols of mathematics.

A FRAMEWORK FOR PROBLEM SOLVING

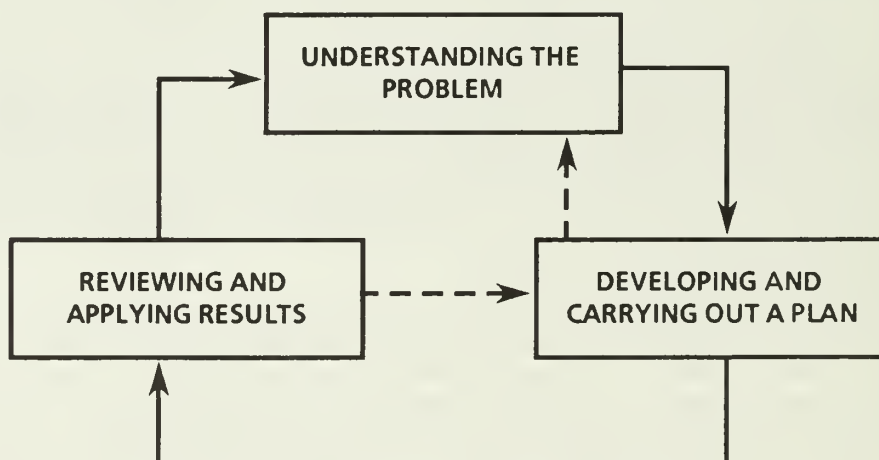
Learning to solve problems is a major goal of the mathematics program. Today's society demands that students are able to accept the challenge of finding ways to clarify and resolve difficulties associated with a variety of perplexing situations. Practice in finding answers to routine word problems in mathematics will not provide students with the problem-solving skills they require. Instead, students must develop critical and creative thinking skills, and be given ample opportunity to apply the mathematical competencies they acquire to new and challenging situations in daily life where:

- a person can be temporarily perplexed
- no readily apparent solution or means to the solution is evident
- there may be no answer, a single answer, or many answers
- personal and societal factors are involved, as well as mathematical competencies.

Problem solving should not be viewed as an isolated activity. Strategies and skills appropriate to problem solving must be explicitly emphasized and frequently incorporated throughout all themes and strands of the curriculum. While a detailed framework for problem solving is outlined on the following pages, additional information can be obtained by referring to Alberta Education's monographs *Problem-Solving Challenge for Mathematics* (1985) and *Problem Solving in Mathematics: Focus for the Future* (1987). Classroom activities that contribute to an understanding of the problem-solving process are provided in the *Teacher Resource Manual*.

A FRAMEWORK

A framework for problem solving is diagrammed below. Although the framework provides an overall structure that can help students to understand the processes used in solving problems, it should not be interpreted as a series of fixed and rigid stages and strategies. There are many ways to approach and solve problems, and the sequence of steps used will depend upon individual problems and individual students. Students may not always go through the steps in the order suggested, nor even use all steps in some problem situations. Nevertheless, an understanding of the steps as well as individual skills that can be used at each stage of the process will increase the students' repertoire of strategies that can be brought to bear on a problem.



Students should recognize that occasionally the results of their efforts in problem solving may be non-productive, and at other times may be so productive as to lead to many different solutions or suggest more problems to solve.

The framework for solving problems in mathematics parallels the framework used for solving problems in other subject areas within the Integrated Occupational Program. It establishes a general "plan for action" that can guide students through a broad range of investigative activities (e.g., problem solving, inquiry, decision making, library research). Familiarity with the framework and actions taken in different kinds of investigation will assist students to transfer problem-solving skills learned in specific contexts to other situations where methods and outcomes may be uncertain. Students should recognize how the framework for solving problems in mathematics is also effective in guiding investigations in English, science, social studies and the occupational program, and how specific skills used at each stage within the framework will vary according to the nature of the task.

USING THE FRAMEWORK

Performance in problem solving can be enhanced by making students conscious of their thought process (i.e., metacognitive awareness). Students need to become aware of and discuss how they think in order to become more strategic in their learning repertoires, and to monitor their problem-solving efforts (e.g., check their answers when in doubt). Teachers can foster this awareness by thinking out loud as they solve problems, by asking questions, and by having students identify the strategies and processes used when solving problems. Teacher modelling of appropriate steps and strategies for solving problems will provide a structure that facilitates the development of effective problem-solving skills (see Instructional Mediation and "Teacher Talk", pp. 29-30).

Various stages and steps in the problem-solving process are clarified in the paragraphs that follow.

UNDERSTANDING THE PROBLEM

During this stage of the problem-solving process, students need to "think about" and interpret the problem situation. Teachers can assist students to focus their attention on information and conditions set in the problem by asking appropriate chains of questions. Teachers can also model and explicitly teach strategies that will help students in particular problem-solving situations.

DEVELOPING AND CARRYING OUT A PLAN

In this stage, students should plan strategies and then use these strategies to actually solve the problem. As students may lack the "strategic repertoire" required to develop a problem-solving plan, it may be necessary to explicitly teach various strategies appropriate to specific problem situations. Emphasize that there are often strategies other than computation that can be used effectively to solve the problem. Once appropriate strategies have been planned, the student simply "carries out the plan" to arrive at a solution.

REVIEWING AND APPLYING RESULTS

This stage encourages students to assess the effectiveness of their solution, and to consider the accuracy of their results. Students need to relate their solutions back to the problem in order to verify that it has indeed been solved. By evaluating problem-solving strategies that have been used, students will become aware of their appropriateness and of other strategies that might also be used. Through discussion and reflection, encourage students to generalize and apply their results to related situations.

Specific strategies that will help students to understand problems, develop and carry out a problem-solving plan, and review/apply the results of problem solving are provided within the Program of Studies/Presentation of Content section of this document (pp. 45-49).

THE ROLE OF THE TEACHER

Critical to the development of skills in problem solving is the attitude with which students approach the task. Appropriate attitudes must be nurtured through an atmosphere that fosters flexibility and acceptance. Students need to accept and appreciate that being perplexed and unsure is often normal when first encountering a challenging situation, and to take risks in the development of particular problem-solving strategies. The guidelines that follow may assist teachers in planning effective problem-solving activities.

- Create a positive classroom atmosphere that facilitates the development of appropriate attitudes and a desire to solve problems by:
 - encouraging students to be creative, and to generate their own ideas and approaches to problem solving
 - providing adequate support and assistance to students, but not solving their problems for them
 - being willing to accept unconventional solutions, more than one solution, or no solution, where appropriate
 - challenging students to think critically and justify strategies and solutions
 - being enthusiastic and capable of recognizing the students' desire and perseverance to solve problems
 - providing appropriate questions and modelling for students.
- Share the problem-solving framework and strategies with all students. The model provides structure to the overall process, as well as specific strategies that might be used at each stage of the process. Familiarity with the model will increase the students' repertoire of strategies that can be brought to bear on a problem.
- Relate the problem-solving model used in mathematics to the models used for solving problems in science, social studies, English and the occupational courses. Students should recognize how the models are similar in the overall structure they provide for problem solving, and how the models may differ in terms of individual strategies appropriate to each stage of problem solving.
- Keep the framework and strategies for problem solving flexible and tentative. Although useful in the structure and support they provide, encourage students to be creative and experimental in their approach to problem solving.
- Select problem-solving activities that emerge from "real life" situations. Ensure that problems are relevant to the interests and experiences of students, and that cognitive demands of the problems match developmental levels of students.
- Modify and vary the approach used so as to ensure interest, participation, and some degree of success by all students. Most students have an inherent desire to accept the challenge provided by a problem.

INTEGRATING TECHNOLOGY INTO THE MATHEMATICS PROGRAM

Developments in technology exert significant influence on society. In order to function successfully within the environments of the home, school, community and workplace, students need to establish a conceptual understanding of technology, as well as strategies for harnessing its potential in productive ways. The *Secondary Education in Alberta* Policy Statement (June 1985) says that:

"An awareness of the advantages and limitations of technological developments, their impact upon society, and the ability to use selected technologies to enhance learning and prepare students for current and future demands of society, are of such importance that all secondary school teachers will be expected to plan and incorporate this component into instructional programs."

Components of technology have been incorporated throughout the mathematics program (see Program of Studies/Presentation of Content, pp. 51-53). Instructional materials and methodology used throughout the mathematics program should provide opportunities for students to:

- learn about technology. This aspect is concerned with developing an awareness of the advantages and limitations of particular technological developments and their impact on society
- learn with technology. This aspect focuses on developing ability to use particular technologies as tools to get work done or as an aid to problem solving (e.g., the hand-held calculator)
- learn through technology. This aspect focuses on the use of technology to deliver and enhance instruction (e.g., computer-assisted instruction, computer-managed learning).

THE CALCULATOR

In order to harness technology productively, students need to become proficient and discerning in the use of a calculator as an aid to computation and problem solving. **All students shall have appropriate calculators available for use throughout the program.**

Effective use of the calculator requires an understanding of place value and the ability to judge the reasonableness of the results of calculations. Skills in estimation and mental arithmetic become increasingly important in enabling students to anticipate and verify calculator results. These experiences will be more effective in developing number sense and cognitive process than long and tedious computations with paper and pencil. Competence in estimation and mental arithmetic can actually be expected to improve through frequent use of these skills while using a calculator. By using calculators appropriately, time previously spent on tedious computation can be used to develop cognitive process and problem-solving skills.

The guidelines that follow will assist in establishing learning environments where the calculator can be used as an effective instructional and computational tool.

- The calculator does not reduce the need for basic arithmetic skills. **Effective use of the calculator requires that an understanding of place value, basic number skills, and arithmetical operations is emphasized throughout the instructional program.**
- There will always be a need to possess limited paper-and-pencil computational skills. **For most students, the calculator should be used after the mathematical concepts and algorithms are understood.** Students who simply cannot master their basic number skills or who have persistent problems with computation should use calculators more extensively.

- The calculator should always be used in situations where long and/or extended computations are required.
- **When using the calculator in problem situations, place emphasis on estimation and mental arithmetic, on proper documentation of numbers and operations used, and on the reasonableness of answers.**
- Do not assume that students understand how to use a calculator. **Be prepared to teach students how and when to use a calculator properly.** Remember, however, that creating a situation just for the sake of using calculators will not develop an understanding of their appropriate use.

THE COMPUTER

Due to developments in microtechnology and the availability of low cost and effective microcomputers, computer technology affects all of us. The traditional meaning of the word "literacy" is taking on a new dimension. To be literate in our changing society, there is an increasing need for students to develop not only the ability to communicate through written and spoken words, but also the skills to interact with computer technology. Although the concepts, skills and attitudes required to be computer literate will vary according to student maturation and ability, the mathematics program should provide opportunities for students to:

- develop an understanding of the basic operation of computers
- recognize the basic capabilities, applications and limitations of computers in society
- work independently with prepared computer software appropriate to course/personal development.

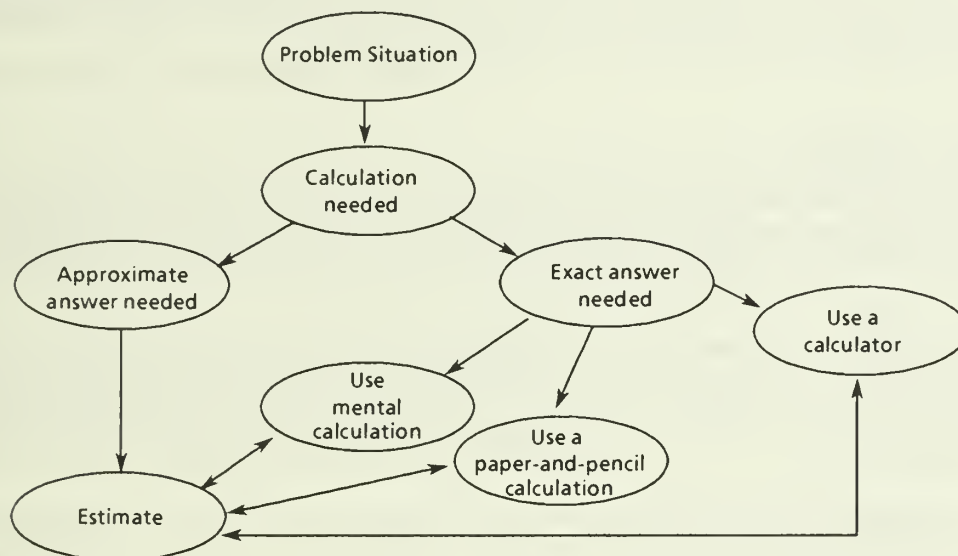
Interactive computer software holds great promise for application in the mathematics classroom. Its value in creating geometric displays, organizing and graphing data, simulating real-life situations, and generating numerical sequences and patterns is already evident. As software development continues to expand, students will be able to interact with computer programs in more highly individualized ways while developing mathematical concepts.

Applications of computer conferencing and networking also continue to expand. To the extent that facilities and equipment are available, students should gain first-hand knowledge of how information and ideas are accessed and shared through computer conferencing and networking systems.

Computer software that supports the development of specific goals and objectives within the mathematics program has been listed in another section of this document (see Learning Resources for Mathematics 16-26, p. 11). The *Teacher Resource Manual* provides suggestions on how these programs and other computer-oriented activities might be used in regular classroom instruction. **Teachers are encouraged to review computer software on an ongoing basis in order to identify resources that address individual student needs and program goals in the most appropriate manner.**

DEVELOPING COMPUTATIONAL FACILITY AND ESTIMATION SKILLS

The availability and use of technology has caused emphasis in the skills required for computational competence to change over the last decade. Computational facility includes more than the knowledge and skills required to perform paper-and-pencil computation with standard algorithms. While these skills are important, responsible participation at home and work also requires facility in performing mental arithmetic, in the application of calculator skills, and in applying strategies of estimation. Surveys show that mental computation and estimation are used in more than 80 percent of all practical problem-solving situations encountered outside the classroom. As important as each method of computation is in itself, even more important is the understanding of when each strategy is most appropriately used in everyday problem-solving situations.



Making Decisions About Computational Procedures
in Problem-Solving Situations¹

A brief description of each method of computation is provided below. Specific strategies that will help students to compute using each method are provided in the Program of Studies/Presentation of Content section of this document (pp. 55-57), as well as in the *Teacher Resource Manual*.

PAPER-AND-PENCIL COMPUTATION

Instruction in paper-and-pencil computation should emphasize place value and basic number skills prior to the application of algorithms. Concrete and visual materials will assist in concept development. Students who have not experienced past success with standard algorithmic procedures may react more favourably and experience more success with less sophisticated forms of algorithms.

The learning of paper-and-pencil computation must focus on an understanding of process, and de-emphasize calculation with large numbers. Addition and subtraction should generally include numbers with no more than four digits. Multiplication and division should be performed on numbers containing up to four digits, using multipliers/divisors of no more than two digits.

¹ Adapted with permission from *Curriculum and Evaluation Standards for School Mathematics*. Copyright 1989 by the National Council of Teachers of Mathematics.

MENTAL ARITHMETIC

The ability to perform mental computations is frequently required of students in a variety of situations. In addition to providing a fast solution to many everyday problems, this skill facilitates the ability to estimate and approximate. Experience with mental computation fosters the development of number sense and enables students to gain confidence in their ability to compute answers.

Students should have knowledge of basic number skills, and be able to apply these skills to more sophisticated processes. Teachers are encouraged to identify mental arithmetic strategies that are most appropriate for their students and to schedule a period of time each week in which these skills can be taught and practised. Short drill and practice activities that become part of the daily routine will promote the development of mental arithmetic skills and foster a habit for their use. Ensure that competition in these activities is with self rather than others in order to avoid humiliation of those who find mental arithmetic difficult. Encourage students to share with other members of the class the personal strategies in mental arithmetic that they find useful.

CALCULATOR SKILLS

Use of the calculator enables students to investigate, see patterns and relationships, and more readily solve problems that require higher levels of thought. Many mathematical problems that would otherwise involve long and unmanageable calculations can be investigated with the calculator.

The use of a calculator does not reduce the need for mastery of basic number skills. Students must recognize that incorrect answers obtained on the calculator result from incorrect numbers being entered or operations entered in the wrong sequence. In order to distinguish a reasonable answer from an unreasonable one, students need to know how to compute using the four operations. Skills in estimation and mental arithmetic are necessary to enable students to anticipate and verify results obtained on the calculator.

Guidelines that foster the development of calculator skills are provided in the Use of Technology section of this document (pp. 51-53).

ESTIMATION

Skill in estimation is necessary for effective problem solving and calculator use. Students need to be able to determine if a particular result is precise enough for the purpose at hand, and be alert to the reasonableness of computational results. More often than not, practical problems involve estimations rather than exact numbers. Estimation, not computation, gives answers to everyday questions like "Do I have enough cash to buy groceries?" and "How many hot dogs should I order for the party?"

Thinking skills and problem solving assume important roles in developing estimation skills. It should be recognized that the process of estimation:

- is performed mentally, usually without paper and pencil
- is done quickly
- produces answers that are not exact, but adequate for making necessary decisions
- reflects individual strategies and produces a variety of estimates as answers.

In order to be able to carry out rapid estimations, students must understand place value, have skill in single-digit operations, be able to multiply and divide by powers of ten, and have facility in rounding whole numbers and decimals to the number of significant digits required by the situation. Students should develop useful estimation strategies, and apply these strategies to whole numbers, decimals, fractions, and percentages. Testing and evaluation should include assessment of the students' ability to estimate in a variety of practical situations.

LANGUAGE DEVELOPMENT IN MATHEMATICS

The strands of language (listening, speaking, reading, writing, viewing) play an important part in the teaching and learning of mathematics. Not only is language a means of communication, but it is also part of the thinking process used to combine ideas, find relationships, ask questions and solve problems. Language development in mathematics should parallel its development in English class by the use of similar strategies.

A distinction should be made between skills that are used to understand mathematics as a technical language, and the use of general language skills in studying mathematics and investigating related problem situations. Instructional planning should include strategies that facilitate language development in both of these areas.

MATHEMATICS AS A TECHNICAL LANGUAGE

The precision of mathematical vocabulary and symbols is often a source of difficulty for students. The everyday meanings associated with words often interfere with an understanding of the specialized meanings words may have in a mathematical context. Each theme within the program should be analyzed in order to identify demands relative to vocabulary and symbolic content. The following questions are useful in planning lessons that provide an understanding of the technical vocabulary used.

- How does this vocabulary relate to everyday usage?
- How does it conflict with everyday usage?
- How does it relate to previously studied mathematical terms?

The role of experience in developing concepts must be recognized and accounted for in vocabulary development activities. Definitions may be developed as summarizing statements of ideas that have been understood, but should not be used as introductions to new vocabulary or symbols. The following instructional sequence can be used to foster meaningful vocabulary development, and ensure that each word or symbol introduced becomes part of the students' active or "working" vocabulary.

- Discuss real-life examples from the students' environment where the word/symbol might be used.
- Simulate concrete and transitional models where the word/symbol might be appropriately used.
- Discuss and list distinguishing characteristics of the word/symbol.
- Record the word/symbol and its distinguishing characteristics (meaning) in a personal "mathematics glossary".

USING LANGUAGE TO UNDERSTAND MATHEMATICS

The role of language in the study of mathematics can be strengthened through the use of questions that probe for explanations rather than stimulate recall of information. Students should frequently be asked "Why?" and encouraged to use language in expressing their ideas, interpretations and answers to questions asked. Opportunities should be provided for students to engage in:

- writing activities that describe mathematical relationships/patterns investigated and the results of problem solving
- speaking and listening activities where thinking and reasoning skills are used with their peers
- reading and viewing activities that are required for problem solving and gathering content or information.

Students can be guided in their reading/viewing for content and information through a sequenced approach that includes the following steps:

- decide on a purpose for reading/viewing, state the purpose as a question
- skim the whole section to get an idea of how it is organized
- notice various "aids" to reading/viewing that have been used in the material (e.g., headings, colour, bold print, charts)
- after reflecting on purpose, decide which sections need intensive study and which may be delayed or skipped
- engage in "active" reading/viewing of the material (e.g., ask questions, think of examples, rephrase in everyday language).

Problem solving necessitates quite a different kind of reading, wherein relationships and patterns often need to be identified and analyzed before solutions can be attempted. Cognitive demands placed upon the student in these situations can be a source of frustration. Instruction must provide support, encouragement and assistance. Model strategies that will guide and facilitate the development of reading skill in this area. The following steps are effective in structuring activities that facilitate the development of reading skills used in problem solving:

- Read rapidly to grasp the general idea
- Read again to determine facts and their relationships.
 - What facts are given?
 - What facts are not given?
 - How does each fact influence other parts of the problem?
- Read again to check facts and relationships
- Determine the steps required for a solution.
 - What do I know?
 - What do I need to know?
 - How can I use what I already know to find out what I need to know?
- Provide a comprehension check by attempting to estimate an answer to the problem.
 - Considering all information, is this answer reasonable?

INSTRUCTIONAL MEDIATION AND "TEACHER TALK"

Recent educational research has focused, in part, on instructional mediation and "teacher talk" in the classroom. Instructional mediation is an interactive process wherein teachers refine their interpretation of tasks to students, as students construct their own interpretations of the tasks and processes being learned. This communication exchange stimulates the development of thinking skills by allowing both teachers and students to contribute to a meaningful learning situation. Lectures, or one-sided explanations, rely on students to be "self-mediating" and to supply their own meaning to processes without the advantage of communication interaction.

Instructional mediation regulates the students' behaviour in terms of the use of strategies and approach to tasks. Emphasis on a strategic view of tasks will encourage students to become independent in the tasks they perform and the processes they use. For example, a strategy for attacking mathematics problems will enable more students to solve problems on their own. In addition, such a strategy enables the student to identify for the teacher at what point they need assistance if they are unable to solve the problem completely.

Instructional mediation can also enhance students' feelings of competency. Students need to see themselves as being successful. Students who feel competent, and who recognize their effort as being effective in learning, are more likely to be persistent in attempting new tasks that are difficult. On the other hand, students who feel incompetent and unsuccessful often require constant praise from external sources. Students who do not recognize that their efforts are effective in the learning process have limited performance goals and are hesitant to engage in any task at which they cannot quickly become successful. Mediation that focuses on the roles of effort and strategy in achieving success will encourage students to extend their learning goals.

Teachers can establish learning environments that foster the development of strategic behaviours and thinking skills by:

- assisting students to identify, analyze and evaluate materials and personal performance
- encouraging students to identify and correct their own errors
- assisting students to pause, revise and clarify at appropriate times
- modelling and encouraging students to use vocalization of thought processes
- encouraging persistence.

The mediation process can also be enhanced through the use of appropriate questioning techniques and by modelling effective behaviours. These approaches are briefly described in the paragraphs that follow.

QUESTIONING TECHNIQUES

Questioning techniques include the use of chains of questions that lead students to discover their own answers. Question chains should begin with focus questions such as:

- What is the goal of this problem?
- What do we want to do?
- What are we looking for?
- What is stopping us?
- Who can we ask?
- Where can we look?
- What should we do first?
- What is this process called?

Once students have established the significant pieces of information necessary to solve the problem, the focus is expanded through questions like:

- What can we do?
- Have we got enough ideas yet?
- What is our next step?
- How will we do that?
- What is the relationship between . . . and . . . ?
- How are . . . and . . . related?
- How can we simplify . . . ?

When students have succeeded with the problem, ask questions that encourage students to review the process used and evaluate their work. These questions may include:

- Have we finished?
- How can we decide if . . . is a reasonable solution?
- How can we check this solution?
- Is there a better solution?
- How do you know that we have solved the problem?
- What are different ways we can approach the problem?
- How could we make our work easier another time?
- When might you use this process again?
- What should we tell others?

Questions that probe and prompt students to process information, rather than fixate at the simple recall level, will encourage students to become actively involved in thinking processes. As students experience success with problems through use of the teacher's chain of questions, they will recognize the importance of the thought processes they have used and develop related strategies that direct their efforts in other tasks.

COGNITIVE MODELLING

Cognitive modelling, as opposed to demonstrating, involves "talking through" a complete process in order to expose thinking processes to the student. While in a demonstration everything turns out as it should, modelling should include false starts, trouble spots, and having to deal with errors. This type of modelling requires teachers to express their thinking processes out loud so that students can see not only how the process is done, but also how difficulties and ambiguities are addressed. As the process is modelled, students should recognize that the teacher's approach may not necessarily be the "best" approach, but simply one way of tackling the problem.

While teachers often model when explaining processes and problems, knowledge and awareness of the value of modelling can serve to refine this process. Asking students where to begin in a problem situation makes a good starting point. If the reply is "I don't know", an area of difficulty is determined. The mini process of "understanding the problem" or "developing a plan" might then be modelled for students.

EVALUATION

Evaluation should be viewed as an ongoing part of the teaching and learning process, providing feedback to students, teachers, and parents/guardians. Major functions served by the process of evaluation include:

- provision of feedback to students relative to individual success in the learning process. Students have difficulty in monitoring and regulating their learning behaviours, and require a great deal of external feedback as to their progress. Feedback and encouragement must be provided on a regular basis
- provision of information to teachers concerning the appropriateness of learning goals and objectives, and the effectiveness of learning strategies and materials that have been used. Such information enables the teacher to modify the program as required with respect to pacing, learning resources, teaching methods or objectives
- provision of information to parents/guardians regarding students' progress. Where possible, reports to parents/guardians should be interpreted through an interview so that the implications of the evaluation are understood. While useful in communicating student progress to parents, the interview is also valuable in identifying individual needs that may be addressed through program planning.

Evaluation should serve diagnostic purposes in identifying student strengths and weaknesses, as well as summative needs in measuring overall growth.* **Because evaluation is an integral part of all aspects of the instructional process, information used in the evaluation of a student should be gathered from a variety of sources, using a variety of methods.**

STRATEGIES FOR EFFECTIVE EVALUATION

Evaluation may, in the past, have been the process by which some students within the program were identified as "failures". These students will go to extreme measures to avoid being "tested" again. Absence from examinations; feigning an "I don't care anyway" attitude; or not giving their best effort so that the anticipated failure can be combatted with "I didn't try my best", are all common behaviours. It is therefore important to provide variation in the assessment procedures used, so as to draw upon students' strengths and provide for their success in the evaluation process. While paper-and-pencil tests may be an effective way of evaluating some learning outcomes, an effective system of evaluation should include use of a variety of sources of information, including:

- observation of attitudes and performance
- oral and written presentations of solutions to problems/mathematical applications
- personal interviews with students
- attitude scales
- samples of individual and project work
- feedback from parents
- teacher rating scales/checklists/inventories
- anecdotal records
- self and peer evaluations
- records of previous achievement
- diagnostic tests
- pre-tests and post-tests on specific objectives, topics or units
- suitable standardized examinations.

*A variety of diagnostic instruments are available through the Alberta Education, Learning Resources Distributing Centre.

The suggestions and strategies provided here are intended to serve as guidelines to the teacher in developing a system of evaluation that will improve both student learning and the quality of the mathematics program offered to students.

- Provide frequent opportunities for students to practise the use of basic number skills, mental arithmetic and estimation. In addition to providing encouragement and feedback to students in the use of these skills, such practice enables the teacher to monitor student achievement in this area.
- Provide opportunities for students to "demonstrate" their understanding of concepts and skills studied through discussion, project work and group activities.
- Observe students in small group situations in order to gain insights as to their:
 - level of independence with the work
 - method of attacking problems
 - ability to apply concepts and skills to new situations.
- Conduct interviews with students following completion of an assignment/project in order to evaluate understanding of concepts/processes/applications. Such interviews may also suggest more effective ways of structuring future assignments.
- Emphasize the "synthesis" of a variety of knowledge and process objectives, rather than isolated skills. Provide students with informal situations where they can demonstrate their application of basic number skills, algorithms, calculator skills, and estimation skills in solving a problem.
- Plan for student success in the evaluation process. Over-dependence on paper-and-pencil techniques often does not permit students with learning difficulties to do well. When planning formal evaluation procedures, caution should be exercised with regard to the overuse of:
 - multiple choice exams
 - difficult wording and vocabulary
 - simple recall of information without understanding and application.
- Provide encouragement by asking questions and making statements that will prompt students to evaluate their work and learning. These techniques will encourage students to be less dependent on external rewards and more responsible for their own learning. Some examples might include:

"You did a good job of ____ (be specific) ____."

"What steps did you find most difficult?"

"How could you improve your work in this question?"
- Provide opportunities for the use of self and peer evaluation techniques. Students should realize that ongoing self-evaluation, as well as external evaluation, is a positive developmental process. Assist students to understand that making mistakes and developing the ability to identify and correct errors are part of the growth process and that mistakes need not be embarrassments.
- Provide adequate time for students to complete their work. Students often do not do their best under time pressure.
- Give students advance notice and a study guide to highlight the areas that need review when planning formal evaluation (e.g., a quiz or a test). Students rarely do their best when caught off guard by "surprise" quizzes.

The *Teacher Resource Manual* contains additional guides and checklists for assessing and evaluating students' performance and achievement in mathematics.

SCOPE AND SEQUENCE

The scope and sequence chart provided on the following pages outlines the mathematical process and skill that is developmentally addressed throughout Mathematics 16 and 26. In recognizing that students differ in the rate at which they acquire mathematical competencies, the chart is intended to assist teachers in assessing present levels of student performance, and in diagnosing individual student strengths and weaknesses. In using the scope and sequence, it should be noted that:

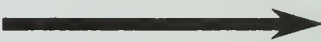
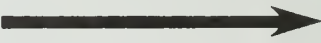
- the chart is not intended to provide a sequenced plan for instruction. **Instruction should be sequenced throughout Mathematics 16 and 26 in a manner that will suit individual student needs and growth patterns**
- learning objectives that provide meaningful **learning contexts** (i.e., problem solving, use of technology, computational facility and estimation) are followed by learning objectives that support the development of process and skill within five **strands of mathematics** (i.e., number systems and operations; ratio, proportion and percent; algebra; geometry and measurement; data interpretation and display) established on the basis of tasks frequently demanded of students in everyday life
- the skills are **developmental** through Mathematics 16 and 26 (i.e., the spiral approach). Mathematics 26 provides opportunities for students to reinforce and extend their understanding of skills developed in Mathematics 16 through more extensive applications, and prescribes new skills related to each of the five strands of mathematics
- most students will continue to use concrete operational thinking, depending upon personal and tangible experience in order to link ideas. Instruction should generally **begin with an operational understanding of ideas** at the Mathematics 16 level, and **encourage students to extend their thinking to more abstract levels that are cognitively appropriate** at the Mathematics 26 level. (The *Teacher Resource Manuals* for Mathematics 16 and 26 provide for the development of thinking skills through themes that reflect increasing levels of analysis and critical thought)
- the skills are **interdependent and are not meant to be taught in isolation**. Although some skills may be mastered more effectively through discrete instruction, this approach is not advocated as a primary focus of instruction. The thematic structure permits a more holistic view of instruction through the linking of strategies and skills.

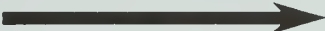
Prescribed components of the mathematics program outlined in the scope and sequence chart should be appropriately clustered and applied to progressively difficult and/or age-appropriate situations as students advance through senior high school. Teachers are encouraged to organize for instruction in ways that are consistent with the abilities, needs and interests of students, using relevant sections of the Program of Studies/Presentation of Content (pp. 43-91), thematic units provided in the *Teacher Resource Manual*, locally developed themes, or a combination of approaches.

Teachers may also wish to examine a scope and sequence chart for the Integrated Occupational Junior High School Mathematics Program (Grades 8 and 9). An understanding of the developmental progression of process and skill occurring in junior high school will facilitate program articulation and continuity.

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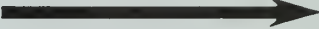
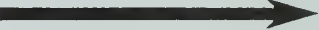
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MATHEMATICS 16	MATHEMATICS 26
DEMONSTRATES ABILITY TO USE A VARIETY OF STRATEGIES/SKILLS IN SOLVING PRACTICAL PROBLEMS THAT REQUIRE QUANTITATIVE THINKING AND COMPUTATIONAL FACILITY.	
• Applies strategies/skills that are useful in understanding a problem. e.g., – reads the problem several times – asks questions and refers to other sources to clarify meaning – identifies key words and their meanings – looks for patterns – identifies given and needed information – identifies extraneous information – internalizes the problem by restating in his or her own words, or by visualizing the problem – draws pictures/diagrams – uses concrete manipulatives – interprets pictures/charts/graphs – relates the problem to other problems previously encountered – considers alternative interpretations of the problem. • Applies strategies/skills that are useful in developing and carrying out a problem-solving plan. e.g., – guesses and checks the result (thus improving the guess) – uses logic or reason – identifies and applies relationships – chooses and sequences the operations needed – sorts and classifies information – applies selected strategies – presents ideas clearly – selects appropriate calculating/measuring devices and methods – acts out or simulates the problem – applies patterns – estimates the answer – documents the process used – works carefully – works in a group situation where ideas are shared – visualizes the problem – makes positive statements (e.g., "I can solve this.") – uses a simpler problem (making an analogy) – identifies factors relevant to the problem – collects and organizes data into diagrams, charts, tables, pictures, graphs or models – experiments through the use of manipulatives – breaks the problem down into smaller parts – formulates an equation – recognizes limits and eliminates possibilities. • Applies strategies/skills that are useful in reviewing and applying the results of problem solving. e.g., – states an answer to the problem – restates the problem with an answer – explains the answer in oral/written form – determines if the answer is reasonable – discusses with others the process used – suggests other ways of solving the problem – checks the answer – considers the possibility of other answers/solutions – makes and solves similar problems – generalizes the solution and applies the process used to other situations.	• Applies strategies/skills that are useful in understanding a problem.  - e.g., – determines if there are hidden assumptions that contain information necessary to the solution of the problem. • Applies strategies/skills that are useful in developing and carrying out a problem-solving plan.  - e.g., – constructs flow charts – works backward through the problem – examines the problem from varying perspectives/points of view. • Applies strategies/skills that are useful in reviewing and applying the results of problem solving.  - e.g., – creates other routine/non-routine problems that require the use of a similar process.

MATHEMATICS 16		MATHEMATICS 26	
DEMONSTRATES ABILITY TO USE A HAND-HELD CALCULATOR IN ROUTINE/NON-ROUTINE PROBLEM SITUATIONS THAT REQUIRE QUANTITATIVE THINKING AND COMPUTATIONAL FACILITY.			
- Identifies appropriate and inappropriate uses of the calculator. - Clears the display of the calculator and corrects entry errors. - Uses the calculator to perform computations with whole numbers, decimals, fractions, integers and percent: - identifies and uses basic functions (i.e., +, -, ×, %, =, decimal, clear) - enters numbers in correct sequence for subtraction and division - determines whole number remainders for division - uses subtotals and memory for adding, subtracting, multiplying and dividing - converts fractions to decimal and percent form - generates sets of multiples for a given number - follows order of operations. - Selects from calculator display the number of decimal places appropriate to the context of a calculation/problem. - Uses estimation and mental arithmetic to check the reasonableness of answers obtained on the calculator.	Applies previously developed calculator skills in progressively difficult and/or age-appropriate situations.		
	Identifies and uses additional functions on the calculator (i.e., x^2, y^x, $\sqrt{}$).		
DEMONSTRATES AN UNDERSTANDING OF THE BASIC OPERATION, CAPABILITIES, APPLICATIONS AND LIMITATIONS OF COMPUTERS.			
- Identifies major parts of a computer. - Distinguishes between hardware and software. - Explains how computers get their instructions from a program written to accomplish a specific task.	Displays knowledge of previously developed concepts/skills related to the basic operation of computers.		
- Gives examples of the applications of computers in performing tasks that require speed, accuracy, repeated operations and the processing of large amounts of data. - Identifies major areas in society where computers are used and the tasks performed by computers in these areas. - Gives examples of tasks that computers cannot accomplish.	Explains the applications and limitations of computers in progressively difficult and/or age-appropriate situations.		

LEARNING CONTEXTS (continued)

COMPUTATIONAL FACILITY AND ESTIMATION

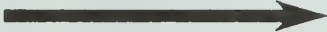
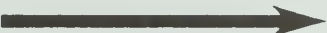
MATHEMATICS 16	MATHEMATICS 26
DEMONSTRATES ABILITY TO PERFORM COMPUTATIONS AS APPROPRIATE IN DAILY LIFE AND WORK-RELATED SITUATIONS, THROUGH THE USE OF MENTAL ARITHMETIC, PAPER-AND-PENCIL ALGORITHMS, THE CALCULATOR AND ESTIMATION.	
• Uses mental arithmetic skills that are based upon: – all single-digit operations – sequences of operations – doubling and halving – multiplying and dividing by powers of 10 – applications of the commutative, associative and distributive properties – properties of zero and one – strategies appropriate to the situation (e.g., compensation, computing from left to right). • Uses paper-and-pencil algorithms to perform computations with whole numbers, decimals, fractions, integers and percent within parameters provided in the Scope and Sequence (see Number Systems and Operations, and Ratio, Proportion and Percent). • Uses the calculator to perform computations with whole numbers, decimals, fractions, integers and percent within parameters established by the nature of the problem (see Use of Technology). • Uses estimation skills that are based upon: – stating the largest and smallest reasonable answer to a problem before solving the problem – predicting whether a computation will result in a larger or smaller number – forecasting an order of magnitude for the result of a computation (e.g., 10's, 100's, 1000's) – predicting the magnitude of the result of a computation through use of strategies appropriate to the situation (e.g., front-end estimation, rounding, clustering, compatible numbers).	• Uses previously developed mental arithmetic skills in progressively difficult and/or age-appropriate situations.  • Uses paper-and-pencil algorithms to perform computations with whole numbers, decimals, fractions, integers and percent within parameters provided in the Scope and Sequence (see Number Systems and Operations, and Ratio, Proportion and Percent). • Uses the calculator to perform computations with whole numbers, decimals, fractions, integers and percent within parameters established by the nature of the problem (see Use of Technology). • Uses previously developed estimation skills in progressively difficult and/or age-appropriate situations. 

STRANDS OF MATHEMATICS

NUMBER SYSTEMS AND OPERATIONS

WHOLE NUMBERS

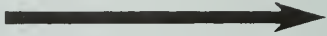
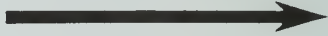
DECIMALS

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APPLIES WHOLE NUMBER SKILLS TO PRACTICAL PROBLEM SITUATIONS INVOLVING SEVERAL STEPS AND OPERATIONS.			
• Identifies place value to one million. • Reads numbers to one million in context. • Writes numbers in numeric or word form to one million. • Quantifies and orders numbers to one million. • Identifies even and odd numbers. • Rounds numbers to nearest 10, 100, 1000, 10 000 and 100 000. • Interprets/uses numerical terms (i.e., pair, triplet, decade, dozen, century). • Adds and subtracts whole numbers (limit for paper-and-pencil computation: numbers less than 10 000). • Uses mental arithmetic to determine products when multiplying by multiples of ten. • Multiplies whole numbers (limit for paper-and-pencil computation: numbers less than 10 000 by numbers less than 100). • Applies divisibility rules for 2, 3, 5 and 10. • Divides whole numbers (limit for paper-and-pencil computation: numbers less than 10 000 by numbers less than 100). • Determines the lowest common multiple for pairs of numbers less than 10. • Expresses numbers up to 50 as the product of prime factors. • Determines the greatest common factor for pairs of numbers less than 50.		• Uses previously developed whole number skills in progressively difficult and/or age-appropriate situations. 	
		• Describes the meaning of terms related to the use of exponents (i.e., exponent, base, power, "squared", "cubed"). • Determines the value of a power, using whole number base and exponents of 2 and 3. • Determines the square root of whole numbers, using estimation/square root tables/calculator.	
APPLIES DECIMAL SKILLS TO PRACTICAL PROBLEM SITUATIONS INVOLVING SEVERAL STEPS AND OPERATIONS.			
• Identifies place value to thousandths. • Reads decimals to thousandths in context. • Writes decimals in numeric form to thousandths. • Quantifies and orders numbers to three decimal places in applications. • Rounds decimals to the nearest whole number, tenth and hundredth. • Adds and subtracts decimals (limit for paper-and-pencil computation: numbers to thousandths). • Multiplies decimals (limit for paper-and-pencil computation: numbers that yield products to thousandths, using one- or two-digit multipliers). • Divides decimals (limit for paper-and-pencil computation: numbers having five digits or less by one- or two-digit divisors; dividend may have 0, 1, 2 or 3 decimal places, divisor may be a whole number or decimal). • Uses mental arithmetic to determine products/quotients when multiplying/dividing by multiples of 10.		• Uses previously developed decimal skills in progressively difficult and/or age-appropriate situations. 	
		• Recognizes place value beyond the thousandths place in work-related situations (e.g., reading the micrometer). • Rounds to the nearest thousandth/ten thousandth as required in work-related situations.	

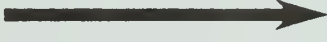
STRANDS OF MATHEMATICS (continued)

NUMBER SYSTEMS AND OPERATIONS

FRACTIONS

MATHEMATICS 16	MATHEMATICS 26
DEMONSTRATES ABILITY TO USE BASIC FRACTION SKILLS IN PRACTICAL PROBLEM SITUATIONS (WITH EMPHASIS ON FRACTIONS HAVING DENOMINATORS OF 2, 3, 4, 5, 8, 10 AND 16).	
• Illustrates a fraction as part of a whole, part of a set, or a point on a number line. • Describes proper/improper fractions and mixed numbers through the use of objects, pictures and diagrams. • Using a number line, illustrates the relationship between whole numbers, decimals and fractions. • Compares and orders fractions in applications. • Identifies and determines equivalent fractions (including proper and improper fractions, mixed numbers). • Identifies and expresses fractions in basic form. • Converts proper/improper/mixed fractions to decimals using a calculator. • Recalls decimal equivalents for one-half, thirds, quarters, fifths and tenths. • Determines common denominators for fractions having denominators of 2, 3, 4, 5, 8, 10 and 16. • Adds/subtracts fractions and mixed numbers having like/unlike denominators that are within the parameters stated above. • Multiplies/divides proper fractions and mixed numbers by whole numbers. • Calculates a fractional part of an amount in applications.	• Applies previously developed fraction skills in progressively difficult and/or age-appropriate situations.  • Multiplies/divides proper fractions and mixed numbers by whole numbers/proper fractions.
DEMONSTRATES ABILITY TO USE INTEGER SKILLS WITHIN THE CONTEXT OF PRACTICAL SITUATIONS.	
• Identifies situations that require the use of integers. • Uses vocabulary related to integers (i.e., positive, negative, plus, minus, above, below, gain, loss). • Places integers on the number line. • Compares and orders integers in practical applications. • Adds pairs/groups of one- and two-digit integers.	• Applies previously developed integer skills in progressively difficult and/or age-appropriate situations.  • Adds/subtracts pairs of integers containing three digits or less. • Multiplies/divides pairs of one- and two-digit integers (where multiplier and divisor are positive). • Describes the use of integers in locating points on the coordinate plane.

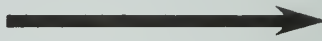
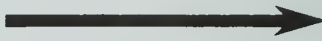
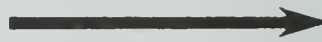
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MATHEMATICS 16	MATHEMATICS 26
DEMONSTRATES ABILITY TO USE RATIO, PROPORTION AND PERCENT SKILLS IN EVERYDAY APPLICATIONS AND PROBLEM-SOLVING SITUATIONS.	
- Compares two quantities in the same unit by writing ratios in the form a/b, $a:b$ and a to b. - Generates equivalent ratios. - Calculates rates/unit rates by writing ratios that involve numbers with different units (e.g., 90 km/2h, 3 items for \$1.00). - Identifies proportions as statements about equivalent ratios. - Writes proportions that describe practical problem situations. - Calculates the unknown value in a proportion. - Expresses whole number percents as ratios/decimals. - Expresses ratios as decimals and percents (i.e., $\frac{a}{b} = \frac{?}{100}$ where $b = 2, 4, 5, 10, 20, 25$ or 50). - Recalls fraction, decimal and percent equivalents for one-half, quarters and tenths. - Expresses one-, two- and three-place decimals as percents. - Determines other fraction, decimal and percent equivalents through the use of the calculator. - Calculates/estimates a percent of a number.	- Applies previously developed ratio, proportion and percent skills in progressively difficult and/or age-appropriate situations.  - Using a calculator, converts fractional percents to fraction and decimal forms (e.g., $12\frac{1}{2}\% = \frac{1}{8} = 0.125$).  - Calculates/estimates what percent one number is of another. - Calculates/estimates any one of the missing elements in practical problems involving application of percent (i.e., determines percentage, rate or base).
DEMONSTRATES ABILITY TO USE ALGEBRA SKILLS WITHIN THE CONTEXT OF EVERYDAY AND WORK-RELATED SITUATIONS.	
- Distinguishes between the use of variables and constants in practical situations. - Uses variables to write mathematical expressions/ equations that describe familiar situations. - Evaluates expressions for given whole number values of the variable. - Uses estimation, guess/check, concrete manipulatives and formal strategies to find whole number solutions for simple equations (e.g., $x \pm a = b$, $ax = b$, $x/a = b/c$, $ax \pm b = c$). - Applies equation-solving skills to practical problem situations. - Interprets formulas as word statements. - Uses formulas and substitution to solve problems in practical situations (e.g., if $P = 2L + 2W$, find P when $L = 10$ and $W = 8$).	- Applies previously developed algebra skills in progressively difficult and/or age-appropriate situations.  - Evaluates expressions for given decimal values of the variable. - Uses estimation, guess/check, concrete manipulatives and formal strategies to find decimal solutions for simple equations (e.g., $x \pm a = b$, $ax = b$, $x/a = b/c$, $ax \pm b = c$). - Applies equation-solving strategies/skills to practical situations involving decimals. - Uses substitution and equation-solving strategies to find the missing element in a formula (e.g., if $P = 2L + 2W$, find L when $P = 16$ and $W = 3$).

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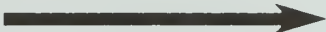
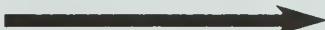
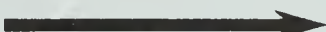
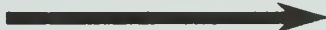
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	MATHEMATICS 16	MATHEMATICS 26
G E O M E T R Y	DEMONSTRATES ABILITY TO APPLY GEOMETRY SKILLS IN DAILY LIFE AND WORK-RELATED SITUATIONS.	
	- Identifies line relationships (i.e., horizontal, vertical, parallel, perpendicular and intersecting). - Identifies/constructs basic two-dimensional geometric figures (i.e., rectangle, square, parallelogram, triangle). - Classifies triangles and quadrilaterals by examining measures of sides and measures of angles. - Identifies the relationship between the radius and diameter of a circle. - Constructs circles, given either radius or diameter. - Identifies similar and congruent geometric figures. - Identifies/sketches/constructs models of basic three-dimensional shapes (i.e., rectangular solid, cube, cylinder, cone). - Constructs geometric figures/designs, using a variety of construction tools (i.e., straightedge, ruler, compass, protractor, computer).	- Applies previously developed geometry skills in progressively difficult and/or age-appropriate situations.  - Identifies/classifies polygons according to the number of sides. - Constructs regular polygons (i.e., triangle, square, hexagon, octagon).  - Describes the terminology associated with the coordinate system (i.e., origin, axis, quadrant, coordinates, ordered pair). - Plots a point on the coordinate plane when given its coordinates, and identifies the coordinates for a point graphed in the coordinate plane.
	DEMONSTRATES ABILITY TO USE APPROPRIATE UNITS AND TOOLS TO ESTIMATE AND MEASURE LENGTH IN DAILY LIFE AND WORK-RELATED SITUATIONS.	
L E N G T H	- Identifies common SI units of length (i.e., mm, cm, m, km). - Estimates/measures length, using metric units and tools appropriate to the situation. - Converts among SI units of length as required in applications. - Estimates/measures/calculates the perimeter of figures bounded by line segments using units and tools appropriate to the situation. - Identifies the value of π as the ratio of the circumference of a circle to its diameter. - Develops/applies strategies for determining the circumference of a circle.	- Applies previously developed skills when measuring length in progressively difficult and/or age-appropriate situations.  - Develops/applies strategies for determining the perimeter of any regular polygon. - Describes the Pythagorean relationship among sides of a right triangle, and applies the relationship to practical situations.
A R E A	DEMONSTRATES ABILITY TO USE APPROPRIATE UNITS AND TOOLS TO ESTIMATE AND MEASURE AREA IN DAILY LIFE AND WORK-RELATED SITUATIONS.	
	- Identifies common SI units of area (i.e., cm^2, m^2) and their application in practical situations. - Approximates the area of two-dimensional geometric figures using a square grid. - Estimates/calculates area of the rectangle, square, triangle and circle, using units, tools and strategies appropriate to the situation.	- Applies previously developed skills when measuring area in progressively difficult and/or age-appropriate situations.  - Develops/applies appropriate strategies for determining the surface area of rectangular solids and cylinders.

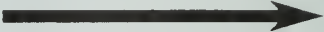
STRANDS OF MATHEMATICS (continued)

GEOMETRY AND MEASUREMENT (cont'd)

MATHEMATICS 16		MATHEMATICS 26	
DEMONSTRATES ABILITY TO USE APPROPRIATE UNITS AND TOOLS TO ESTIMATE AND MEASURE VOLUME IN DAILY LIFE AND WORK-RELATED SITUATIONS.			
- Identifies common SI units of volume (i.e., cm³, m³) and their application in practical situations. - Approximates the volume of rectangular solids using cubes. - Estimates/calculates the volume of rectangular solids and cubes, using units, tools and strategies appropriate to the situation.	Applies previously developed skills when measuring volume in progressively difficult and/or age-appropriate situations. 	- Identifies the equivalence between cubic centimetres and millilitres. - Develops/applies appropriate strategies for determining the volume of right cylinders.	
DEMONSTRATES ABILITY TO USE APPROPRIATE UNITS AND TOOLS TO ESTIMATE AND MEASURE CAPACITY IN DAILY LIFE AND WORK-RELATED SITUATIONS.			
- Identifies common SI units of capacity (i.e., mL, L) and their application in practical situations. - Estimates and measures capacity, using metric units and tools appropriate to the situation. - Converts between mL and L.	Applies previously developed skills when measuring capacity in progressively difficult and/or age-appropriate situations. 		
DEMONSTRATES ABILITY TO USE APPROPRIATE UNITS AND TOOLS TO ESTIMATE AND MEASURE MASS IN DAILY LIFE AND WORK-RELATED SITUATIONS.			
- Identifies common SI units of mass (i.e., g, kg, t) and their application in practical situations. - Estimates and measures mass, using metric units and tools appropriate to the situation. - Converts between g and kg and between kg and t.	Applies previously developed skills when measuring mass in progressively difficult and/or age-appropriate situations. 		
DEMONSTRATES ABILITY TO USE APPROPRIATE UNITS AND TOOLS TO ESTIMATE AND MEASURE TIME IN DAILY LIFE AND WORK-RELATED SITUATIONS.			
- Uses a calendar, recognizing the relationship between days, weeks, months and years. - Uses accepted standards for numeric dating. - Estimates/measures/records time on the 12-hour and 24-hour clocks, using traditional and digital time pieces. - Determines the interval between a pair of times. - Determines the finishing time, given the starting time and duration.	Applies previously developed skills when measuring time in progressively difficult and/or age-appropriate situations. 		
	DEMONSTRATES ABILITY TO ESTIMATE AND MEASURE TEMPERATURE IN DAILY LIFE AND WORK-RELATED SITUATIONS.		
	- Estimates/measures temperature on the Celsius scale. - Recalls important temperatures on the Celsius scale (i.e., boiling/freezing point of water, normal room/body temperature). - Determines temperature change, including changes from below zero to above zero and vice versa.		
DEMONSTRATES ABILITY TO USE APPROPRIATE UNITS AND TOOLS TO ESTIMATE AND MEASURE ANGLES IN DAILY LIFE AND WORK-RELATED SITUATIONS.			
- Identifies an angle and the degree as a unit of measure. - Identifies/estimates angles of 30°, 45°, 60°, 90°, 180° and 360°. - Uses a protractor to measure and draw angles from 0° to 180°.	- Applies previously developed skills when measuring angles in progressively difficult and/or age-appropriate situations. - Uses a protractor to measure and draw angles from 0° to 360°. - Applies knowledge of the sum of the angles of a triangle in practical situations.		

STRANDS OF MATHEMATICS (continued)

D A T A I N T E R P R E T A T I O N A N D D I S P L A Y

MATHEMATICS 16	MATHEMATICS 26
COLLECTS, ORGANIZES, DISPLAYS AND ANALYZES NUMERICAL DATA IN ORDER TO DRAW VALID INFERENCES AND MAKE INFORMED DECISIONS IN EVERYDAY SITUATIONS.	
• Distinguishes between a survey and census, also between a sample and population, identifying potential biases that may occur in surveys and samples. • Interprets and analyzes data presented in tables/charts and bar/line/picture/circle graphs. • Displays data in the form of tables/charts and bar/line/picture/circle graphs. • Identifies the characteristics of a misleading graphical display. • Determines/calculates appropriate measures of central tendency in practical situations (i.e., mean, median, mode, range). • Conducts a survey or poll, using appropriate methods of gathering, organizing, presenting and analyzing data: – selects a suitable sample from a given population – collects and organizes data using tally sheets/frequency tables – displays data in the form of bar/line/picture/circle graphs – makes inferences/generalizations about the population from which a sample was taken.	• Applies previously developed statistical skills in progressively difficult and/or age-appropriate situations.  • Explains the meaning of "probability" and gives examples of its use in today's society. • Uses counting techniques such as tree diagrams/charts to determine the number of ways that an event can happen. • Expresses the probability of the occurrence of a single event related to practical experience or a simple experiment.

PROGRAM OF STUDIES/PRESENTATION OF CONTENT

The Program of Studies/Presentation of Content outlines the concepts, skills and attitudes prescribed for Mathematics 26. Learning objectives that relate to each of the learning contexts are followed by learning objectives within each of five strands of mathematics, and include:

- | | | |
|---|---|------------------------|
| <ul style="list-style-type: none"> ● Problem Solving ● Use of Technology ● Computational Facility and Estimation | } | learning contexts |
| <ul style="list-style-type: none"> ● Number Systems and Operations ● Ratio, Proportion and Percent ● Algebra ● Geometry and Measurement ● Data Interpretation and Display. | } | strands of mathematics |

Shaded statements contained in the Program of Studies (Column One) enable the reader to readily identify those portions of the program that are prescribed.

The advice and direction offered throughout Columns Two, Three and Four are not prescriptive, but are offered only as a service to teachers. Column Two, Related Life Skills, establishes an immediate need or use for each skill being studied and suggests ways of planning relevant learning experiences. Further suggestions for relating mathematical competencies to applications in occupational courses and other academic disciplines are provided in Column Three, Related Applications Across the Curriculum. The references provided in this column will facilitate curricular integration by establishing a base for cooperative planning among other subject areas/teachers in the program. A variety of strategies useful in addressing developmental characteristics and learning styles of the student are provided in Column Four, Suggested Strategies/Activities. Teachers are encouraged to use the advice and direction offered throughout Columns Two, Three and Four in conjunction with suggestions provided in the *Teacher Resource Manual* when planning thematic units of instruction that address learning objectives identified in the Program of Studies (Column One).

Prescribed learning objectives outlined in the Program of Studies should be appropriately clustered and applied to progressively difficult and/or age-appropriate situations as students advance through senior high school. Teachers are encouraged to organize for instruction in ways that are consistent with the abilities, needs and interests of students, using relevant sections of the Program of Studies/Presentation of Content, thematic units provided in the *Teacher Resource Manual*, locally developed themes, or a combination of approaches.

MATHEMATICS 26

PROBLEM SOLVING

Problem solving is to be integrated throughout all areas of the mathematics program, as learning to solve problems is a major purpose of studying mathematics. Students should recognize that problems can be solved in many ways, and will be expected to use a variety of strategies that help them to understand problems, develop and carry out a problem-solving plan, and review/apply the results of problem solving.

CONCEPTS

Students will be expected to demonstrate an understanding that:

- problems can be routine, requiring only the application of a known procedure/algorithm, or non-routine, requiring the development of a process or the conducting of an investigation
- a variety of strategies/skills are useful in understanding and solving mathematical problems
- computational facility, involving the use of paper-and-pencil algorithms, estimation, mental arithmetic and/or the calculator may assist the problem-solving process.

SKILLS

The skills relating to **PROBLEM SOLVING** are outlined in the Learning Objectives listed in Column One on the pages that follow.

ATTITUDES

Students will be encouraged to:

- display a positive attitude toward the application of concepts and skills in mathematics by
 - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
 - solving mathematical problems and completing assignments independently and in cooperation with others
- appreciate the value of an organized approach to problem solving
- display an attitude of curiosity and openness to new ideas, and to be critical and constructive when selecting and applying problem-solving strategies in practical situations
- appreciate the usefulness of problem-solving skills in consumer and work-related situations.

LEARNING OBJECTIVESRelated Life Skills

DEMONSTRATES ABILITY TO USE A VARIETY OF STRATEGIES/SKILLS IN SOLVING PRACTICAL PROBLEMS THAT REQUIRE QUANTITATIVE THINKING AND COMPUTATIONAL FACILITY.

- Applies strategies/skills that are useful in understanding a problem.
 - e.g., – asks questions and refers to other sources to clarify meaning
 - looks for patterns
 - identifies given and needed information
 - identifies extraneous information
 - internalizes the problem by restating in his or her own words, or by visualizing the problem
 - draws pictures/diagrams
 - uses concrete manipulatives
 - interprets pictures/charts/graphs
 - relates the problem to other problems previously encountered
 - simulates/models the problem situation
 - considers alternative interpretations of the problem
 - determines if there are hidden assumptions that contain information necessary to the solution of the problem.
- Applies strategies/skills that are useful in developing and carrying out a problem-solving plan.
 - e.g., – guesses and checks the result (thus improving the guess)
 - uses logic or reason
 - identifies and applies relationships
 - sorts and classifies information
 - presents ideas clearly
 - selects appropriate calculating/measuring devices and methods
 - acts out or simulates the problem
 - applies patterns
 - estimates the answer
 - documents the process used
 - works in a group situation where ideas are shared
 - visualizes the problem
 - makes positive statements (e.g., "I can solve this.")
 - uses a simpler problem (making an analogy)
 - identifies factors relevant to the problem.

Recognizes that computational competence may assist the problem-solving process. Performs computations, using whole numbers/decimals/fractions/integers, when solving "real life" problems related to:

- personal finance/management
- situations encountered at work
- home maintenance
- travel/sport/recreation.

Recognizes that the computational processes performed when solving problems may involve the use of:

- paper-and-pencil algorithms
- estimation
- mental arithmetic
- technology (e.g., calculator, computer).

Selects the most appropriate method of computation to use in everyday problem situations.

Applies appropriate problem-solving strategies to situations that are routine, involving the application of specific concepts/skills:

- determines the quantity/cost of materials required for a project
- determines the "best buy" by comparing the unit price of competing products.

Applies appropriate problem-solving strategies to situations that are non-routine and open-ended, requiring the use of creative thinking and ability to recognize different solutions:

- selects an appropriate store for purchase of sportswear after considering selection/quality/cost/service at a number of competing stores
- examines alternative sources of consumer loans and makes an informed decision after considering interest rates/duration of loan/collateral needed/non-payment penalties.

Related Applications Across the Curriculum

General

The framework for solving problems in mathematics parallels the framework used for solving problems in other subject areas within the Integrated Occupational Program. The framework establishes a general "plan for action" that can guide students through a broad range of investigative activities that may include:

- problem solving
- inquiry
- decision making
- library research.

Students are encouraged to discern similarities among the actions taken in different kinds of investigation, and to transfer problem-solving skills learned in specific contexts to other situations where methods and outcomes may be uncertain.

English

Identifies problem-solving/decision-making strategies used by characters in literature and fictional media such as television programs and movies. Develops and evaluates alternative strategies.

Science

Uses appropriate thought processes and thinking strategies when:

- conducting scientific inquiry
- solving technological problems
- making responsible decisions in society.

Social Studies

Uses problem-solving and decision-making strategies to investigate:

- current issues relating to the Canadian identity
- the influence of specific world events on career opportunities in the community.

Suggested Strategies/Activities

Problem solving must be integrated throughout all areas of the mathematics program, and should be developed within the context of real-life and work-related situations. The learning objectives outlined in Column One provide an overview of the strategies/skills that can be developed through themes provided in the *Teacher Resource Manual*.

Plan instructional activities that focus attention on:

- ability to set up problems with the appropriate operations
- a variety of strategies for approaching and working on problems
- the underlying mathematical features of a problem
- ability to work with others when solving a problem
- open problem situations, since many everyday problems are not well formulated.

Consider individual differences when providing students with problems that are appropriate to their level of ability. Select routine problems that can be solved independently through the application of familiar techniques, and non-routine and open-ended problems that may involve small groups or the entire class working cooperatively in developing creative and/or divergent thinking skills.

Encourage students to accept and appreciate that being perplexed and unsure is often normal when first encountering a problem situation. Create a positive classroom atmosphere that allows students to foster their own ideas and approaches to problem solving. Student attitudes and beliefs that build self-confidence in problem situations include:

- "Problems can be solved in more than one way"
- "Problems may have more than one answer"
- "If the first strategy I try doesn't work, I'll try to find another strategy".

Model the problem-solving process for students (see Instructional Mediation and "Teacher Talk", pp. 29-30). Facilitate active involvement in problem solving by encouraging students to:

- ask questions
- manipulate materials
- discuss and share ideas/strategies in small groups
- verbalize their ideas and discoveries
- think of related problems from personal experience.

LEARNING OBJECTIVES

Related Life Skills

- Applies strategies/skills that are useful in developing and carrying out a problem-solving plan (continued).
e.g.,
 - collects and organizes data into diagrams, charts, tables, pictures, graphs or models
 - experiments through the use of manipulatives
 - breaks the problem down into smaller parts
 - formulates an equation
 - recognizes limits and eliminates possibilities
 - constructs flow charts
 - works backward through the problem
 - examines the problem from varying perspectives/points of view.
- Applies strategies/skills that are useful in reviewing and applying the results of problem solving.
e.g.,
 - restates the problem with an answer
 - explains the answer in oral/written form
 - determines if the answer is reasonable
 - discusses with others the process used
 - suggests other ways of solving the problem
 - considers the possibility of other answers/solutions
 - makes and solves similar problems
 - generalizes the solution and applies the process used to other situations
 - creates other routine/non-routine problems that require the use of a similar process.

Distinguishes between everyday problems that require exact answers and those that require only an estimation. Selects methods of computation that are appropriate to each type of problem-solving situation.

Translates "real life" problems into mathematical statements, and mathematical problems and answers back into "real life" context.

Identifies practical problems that:

- have more than one possible solution
- cannot be solved because of insufficient information.

Develops a habit of using estimation to check the results of problem solving:

- "Is my answer reasonable?"
- "Within what range of numbers must my answer lie?"

Related Applications Across the Curriculum

Suggested Strategies/Activities

Occupational Courses

Uses problem-solving and decision-making strategies to:

- design/produce a product
- provide a service.

CALM

Uses problem-solving and decision-making strategies when investigating:

- financial planning and budgeting
- the use of banking institutions
- the use of credit
- consumer skills.

Provide opportunities for students to develop proficiency in using a variety of methods of computation, including mental arithmetic, paper-and-pencil, the calculator and estimation. Coach students in the discerning use of each method in the problem-solving process, thus avoiding singular emphasis on the use of paper-and-pencil algorithms.

Students should not be evaluated on their ability to solve problems simply by what they produce on paper. Attitudes and behaviours that may also be taken into account include:

- willingness to attempt a problem
- use of appropriate strategies
- willingness to try other strategies
- perseverance in the task
- willingness to contribute to group problem-solving activities
- willingness to solicit/accept help from others.

Use a variety of techniques to gather information regarding each student's progress in the problem-solving process (e.g., observation, questioning, interviewing). Sample checklists, inventories, rating scales that provide a means for recording the development of desirable attitudes and behaviours are included in the *Teacher Resource Manual* (see Problem Solving and Assessment/Evaluation).

MATHEMATICS 26

USE OF TECHNOLOGY

Students must develop an understanding of the pervasiveness of technology, its advantages and limitations in society, and strategies for harnessing its potential in productive ways. Each student should have access to a hand-held calculator, and will be expected to become proficient and discerning in its use. To the extent that computer facilities and equipment are available, students should be given opportunity to work independently with prepared software and to use simple programs that have been written for particular purposes.

CONCEPTS

Students will be expected to demonstrate an understanding that:

- calculators and computers have influenced the nature of the computational procedures and problem-solving processes that we use
- computer technologies have basic capabilities and limitations that determine the nature of the tasks they perform
- effective use of calculators and computers requires knowledge of appropriate procedures for their use.

SKILLS

The skills relating to **USE OF TECHNOLOGY** are outlined in the Learning Objectives listed in Column One on the following page.

ATTITUDES

Students are encouraged to:

- display a positive attitude toward the application of concepts and skills in mathematics by
 - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
 - solving mathematical problems and completing assignments independently and in cooperation with others
- demonstrate confidence in their ability to use a calculator effectively in problem-solving situations that require quantitative thinking and computational facility
- appreciate current and potential impacts of computer technology in everyday and work-related situations.

LEARNING OBJECTIVES

Related Life Skills

DEMONSTRATES ABILITY TO USE THE HAND-HELD CALCULATOR IN ROUTINE/NON-ROUTINE PROBLEM SITUATIONS THAT REQUIRE QUANTITATIVE THINKING AND COMPUTATIONAL FACILITY.

- Applies previously developed calculator skills in progressively difficult and/or age-appropriate situations:
 - identifies appropriate and inappropriate uses of the calculator
 - clears the display of the calculator and corrects entry errors
 - uses basic functions on the calculator to perform computations with whole numbers, decimals, fractions, integers and percent
 - selects from calculator display the number of decimal places appropriate to the context of a calculation/problem
 - uses estimation and mental arithmetic to check the reasonableness of answers obtained on the calculator.
- Identifies and uses additional functions on the calculator (i.e., x^2 , y^x , $\sqrt{\quad}$).

DEMONSTRATES AN UNDERSTANDING OF THE BASIC OPERATION, CAPABILITIES, APPLICATIONS AND LIMITATIONS OF COMPUTERS.

- Displays knowledge of previously developed concepts/skills related to the basic operation of computers:
 - identifies major parts of a computer
 - distinguishes between hardware and software
 - explains how computers get their instructions from a program written to accomplish a specific task.
- Explains the applications and limitations of computers in progressively difficult and/or age-appropriate situations:
 - gives examples of the applications of computers in performing tasks that require speed, accuracy, repeated operations and the processing of large amounts of data
 - identifies major areas in society where computers are used and the tasks performed by computers in these areas
 - gives examples of tasks that computers cannot accomplish.

Follows appropriate procedures for storing, handling and operating calculators and computer hardware/software.

Uses a calculator in situations where mental arithmetic would be difficult, or when paper-and-pencil computation would be inefficient:

- determining quantity/cost of materials required for a construction/repair project
- monitoring total cost of a number of items being selected for purchase
- determining unit price and "best buy"
- verifying sales slips/invoices/bills
- maintaining bank account balances
- determining gross pay and net pay
- preparing an income tax return
- comparing loan costs
- monitoring fixed and variable costs in operating a business/home.

Makes a habit of using estimation to check the reasonableness of computational results obtained using the calculator.

Uses system commands to run prepared programs on a computer. Locates/uses alphanumeric and special function keys on a computer keyboard.

Recognizes the capabilities of computers in preparing graphical representations.

Understands the applications of computer spreadsheets.

Identifies the tasks performed by computer technologies in a variety of "real life" situations:

- banking
- consumer transactions.

Appreciates current and potential impacts of computer technology on:

- employment and career opportunities
- career education and job training.

Related Applications Across the Curriculum

Suggested Strategies/Activities

English

Uses appropriate computer technologies as an aid to:

- gathering and organizing information
- communicating information and ideas in the form of printed reports, charts and graphs.

Science

Uses a calculator when performing calculations in a variety of classroom/laboratory situations.

Identifies various tasks performed by computers in:

- managing environment and resources
- monitoring personal health.

Recognizes the impact of computer technologies on personal lifestyle and employment/career opportunities.

Social Studies

Uses a calculator when interpreting statistical data related to:

- population distribution in Canada
- import/export markets and goods
- regional differences involving economics, resources, education and employment opportunities.

Recognizes the impact of computer technologies on:

- employment opportunities
- voting procedures
- global communication.

Occupational Courses

Uses a calculator to perform computations within the context of managing finances, inventory and other quantifiable materials.

Recognizes the impact of computer technology on:

- the manufacturing industry
- business practices/procedures
- employment/career opportunities.

Calculators and computer technology should be used by students throughout the mathematics program in support of instruction, class work, assignments and evaluation. Contrary to the fears of many, the availability of calculators and computers will expand students' capabilities for performing calculations. Their use will decrease the time spent on tedious computation (e.g., column addition, long division), thus allowing for an increase in time and emphasis on cognitive process and problem solving. There is no evidence to suggest that the availability of calculators makes students dependent on them for simple calculations.

Encourage students to use calculators on a regular basis when the purpose of an activity is the development of problem solving or other skills in which computation is of secondary importance. Be prepared to provide instruction on how to use the calculator in problem-solving contexts. Activities with the calculator should focus attention on:

- knowledge and use of place value, basic number skills and arithmetical operations
- proper documentation of numbers and operations that are used
- the development of skills in estimation and mental arithmetic
- ability to judge the reasonableness of an answer
- an appreciation of the importance of making a judgment about the results of computation.

For most students, the calculator should be used after mathematical concepts and algorithms are understood. Students who simply cannot master their basic number skills or who have persistent problems with computation may find further efforts toward mastering computational skills counter-productive, and should use calculators more extensively.

Provide opportunities for students to work with prepared software on a computer, and to enter, run and modify simple "user friendly" computer programs. These experiences will support concept and skill development, while at the same time enable students to interact with computers and gain first-hand knowledge of their applications and limitations.

Select computer programs and software on the basis of their effectiveness in:

- developing mathematical concepts/skills
- assisting the problem-solving process (e.g., performing iterative calculations)
- providing for drill and practice.

The *Teacher Resource Manual* provides additional suggestions on how calculators and computer technology can be used in regular classroom instruction throughout the mathematics program (see Themes and Use of Technology).

MATHEMATICS 26

COMPUTATIONAL FACILITY AND ESTIMATION

Students must understand that there are several ways to perform numerical computations, and that the method chosen will depend upon the situation at hand. Each student will be expected to develop strategies for performing computations through the use of mental arithmetic, paper and pencil, the calculator and estimation). Instruction should also enable students to discern when each method is most appropriately used in everyday problem-solving situations, and to determine whether or not answers are reasonable. It is intended that related concepts, skills and attitudes be developed/reinforced throughout the mathematics program, within the context of "real life" and work-related situations.

CONCEPTS

Students will be expected to demonstrate an understanding that:

- computation can be performed by a variety of methods, and may include the use of mental arithmetic, paper-and-pencil algorithms, estimation and the calculator
- one must consider the degree of precision/accuracy that is required when selecting a method of computation that is appropriate to a particular problem situation
- checking an answer for its reasonableness and accuracy is a fundamental step in the computational process
- estimation is useful in determining the reasonableness of the results of computation and problem solving.

SKILLS

The skills relating to **COMPUTATIONAL FACILITY AND ESTIMATION** are outlined in the Learning Objectives listed in Column One on the following page.

ATTITUDES

Students will be encouraged to:

- display a positive attitude toward the application of concepts and skills in mathematics by
 - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
 - solving mathematical problems and completing assignments independently and in cooperation with others
- demonstrate flexibility and ingenuity when selecting and applying appropriate methods of computation in daily life and work-related situations
- appreciate the usefulness of computational facility and estimation in solving everyday problems and making informed decisions.

LEARNING OBJECTIVESRelated Life Skills

DEMONSTRATES ABILITY TO PERFORM COMPUTATIONS AS APPROPRIATE IN DAILY LIFE AND WORK-RELATED SITUATIONS, THROUGH THE USE OF MENTAL ARITHMETIC, PAPER-AND-PENCIL ALGORITHMS, THE CALCULATOR AND ESTIMATION.

- Uses previously developed mental arithmetic skills that are based upon:
 - all single-digit operations
 - sequences of operations
 - doubling and halving
 - multiplying and dividing by powers of 10
 - applications of the commutative, associative and distributive properties
 - properties of zero and one
 - strategies appropriate to the situation (e.g., compensation, computing from left to right).
- Uses paper-and-pencil algorithms to perform computations with whole numbers, decimals, fractions, integers and percent within parameters provided in the Scope and Sequence (see "Number Systems and Operations" and "Ratio, Proportion and Percent").
- Uses the calculator to perform computations with whole numbers, decimals, fractions, integers and percent within parameters established by the nature of the problem (see "Use of Technology").
- Uses previously developed estimation skills that are based upon:
 - stating the largest and smallest reasonable answer to a problem before solving the problem
 - predicting whether a computation will produce a number that is larger or smaller than a given number
 - forecasting an order of magnitude for the result of a computation (e.g., 10's, 100's, 1 000's)
 - predicting the magnitude of the result of a computation through use of strategies appropriate to the situation (e.g., front-end estimation, rounding, clustering, compatible numbers).

Distinguishes between "real life" situations that require exact answers and those that require only an estimation. Selects a method of computation appropriate to each situation:

- "Do I have enough money to buy these articles?"
- "Brand X is the best buy."
- "A 15% tip would be about . . . dollars."
- "My net pay will be . . ."

Uses mental arithmetic in daily activities:

- "How much will I pay for both the tape and the shirt?"
- "Have I received the correct amount of change?"
- "How much sugar will I need if I double the recipe?"

Uses a calculator in situations where mental arithmetic would be difficult, or when paper-and-pencil computation would be inefficient.

Makes a habit of using estimation to check the reasonableness of computational results obtained using paper and pencil or the calculator:

- "Is my answer reasonable?"
- "Within what range of numbers must my answer lie?"

Uses estimation skills in daily life situations where approximate numbers or answers are more appropriate than exact numbers:

- "Is there enough gas in the car?"
- "How much should I tip?"
- "How many people were at the game?"
- "How long will the trip take?"
- "Is this a reasonable price to pay?"
- "Is the answer on my calculator 'in the right ballpark'?"

Applies appropriate strategies of estimation in consumer-related situations:

- selects items for purchase on the basis of approximate cost comparisons
- approximates total cost of items selected for purchase
- checks accuracy of sales receipts
- anticipates change due when paying for a purchase.

Related Applications Across the Curriculum

Suggested Strategies/Activities

General

Computational procedures are used to varying degrees throughout all subject areas. Ensuing pages of this document will describe:

- the context in which computation is used in other subject areas
- the nature of the skills used by students.

Science

Selects/uses computational methods (i.e., mental arithmetic, paper-and-pencil, calculator, estimation) that are appropriate to a variety of classroom/laboratory situations.

Social Studies

Selects/uses methods of computation that are appropriate to the situation when:

- working with distances and scales on a map
- interpreting/analyzing statistical data related to various topics.

Uses estimating and predicting skills to hypothesize the outcome of a current event reported in the media.

Occupational Courses

Performs computations within the context of managing:

- finances
- inventory
- other quantifiable materials.

Selects a method of computation (i.e., mental arithmetic, paper-and-pencil, calculator, estimation) that is appropriate to the nature of the problem or purpose of the activity.

Provide opportunities throughout the mathematics program for students to increase their proficiency in using a variety of methods of computation (i.e., mental arithmetic, paper-and-pencil, calculator, estimation). Coach students in the discerning use of each method in the problem-solving process, thus avoiding singular emphasis on the use of paper-and-pencil algorithms.

Maintain and develop mental arithmetic skills on a regular basis through timed challenges and games that are appropriate to student ability (see *Teacher Resource Manual: Computational Facility and Estimation*). Model "easy to use" strategies that will assist students to compute mental exact answers in situations of increasing difficulty. Encourage students to share strategies they find useful with other members of the class. Develop an evaluation plan that reflects commitment to mental arithmetic skills. Regular assessment of mental arithmetic skills will focus students' attention on the importance of these skills.

While proficiency with paper-and-pencil algorithms is important, such knowledge should grow out of problem situations that give rise to the need for such algorithms. Instruction in paper-and-pencil computation should continue to emphasize understanding of process (i.e., place value, regrouping, borrowing) and why algorithms are constructed in particular forms. Reinforce these understandings through work with one-, two- and three-digit numbers. Tedious paper-and-pencil computations with numbers containing more than four digits are discouraged. Such computations are time-consuming, and are generally ineffective in facilitating the development of number sense and problem-solving ability.

Estimation involves application of a set of skills that are developed over time through much opportunity for practice. Encourage students to use estimation skills on a daily basis in applications and problem solving, and to recognize that:

- estimation is important and useful
- many everyday problem situations require only an estimate
- there are many ways to obtain reasonable estimates.

Appropriate strategies for developing estimation skills are provided in the *Teacher Resource Manual* (Computational Facility and Estimation). Model these strategies and "think out loud" with students. Provide opportunities for students to share other estimation strategies they find useful with members of the class.

Estimation skills are often best evaluated through daily questioning and informal observation. Formal assessment of these skills can be counter-productive, as it may encourage students to make an approximation after obtaining an exact answer.

MATHEMATICS 26

NUMBER SYSTEMS AND OPERATIONS

Students will be expected to demonstrate knowledge of the basic properties of whole numbers, decimals, fractions and integers, and of appropriate strategies for performing operations with these numbers. Instructional activities should provide opportunities for students to build concepts and demonstrate understandings through the use of concrete models and materials. It is intended that related activities occur within the context of "real life" and work-related situations, rather than as a topic on their own.

CONCEPTS

Students will be expected to demonstrate an understanding that:

- effective use of whole numbers, decimals, fractions and integers requires knowledge of appropriate notation and number properties
- performing operations of addition, subtraction, multiplication and division with whole numbers, decimals, fractions and integers involves the application of certain processes
- checking an answer for reasonableness and accuracy is a fundamental step in performing operations with number systems
- computation with whole numbers, decimals, fractions and integers may involve the use of paper-and-pencil algorithms, estimation, mental arithmetic and/or the calculator.

SKILLS

The skills relating to **NUMBER SYSTEMS AND OPERATIONS** are outlined in the Learning Objectives listed in Column One on the pages that follow.

ATTITUDES

Students will be encouraged to:

- display a positive attitude toward the application of concepts and skills in mathematics by
 - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
 - solving mathematical problems and completing assignments independently and in cooperation with others
- appreciate the usefulness of whole numbers, decimals, fractions and integers in practical everyday activities and work-related situations
- display an attitude of curiosity and openness to new ideas, and to be critical and constructive when selecting and applying computational procedures in problem-solving situations.

LEARNING OBJECTIVES

Related Life Skills

WHOLE NUMBERS

APPLIES WHOLE NUMBER SKILLS TO PRACTICAL PROBLEM SITUATIONS INVOLVING SEVERAL STEPS AND OPERATIONS.

- Uses previously developed whole number skills in progressively difficult and/or age-appropriate situations:
 - identifies place value to one million
 - reads numbers to one million in context
 - writes numbers in numeric or word form to one million
 - quantifies and orders numbers to one million
 - identifies even and odd numbers
 - rounds numbers to nearest 10, 100, 1 000, 10 000 and 100 000
 - interprets/uses numerical terms (i.e., pair, triplet, decade, dozen, century)
 - adds and subtracts whole numbers (limit for paper-and-pencil computation: numbers less than 10 000)
 - uses mental arithmetic to determine products when multiplying by multiples of ten
 - multiplies whole numbers (limit for paper-and-pencil computation: numbers less than 10 000 by numbers less than 100)
 - applies divisibility rules for 2, 3, 5 and 10
 - divides whole numbers (limit for paper-and-pencil computation: numbers less than 10 000 by numbers less than 100)
 - determines the lowest common multiple for pairs of numbers less than 10
 - expresses numbers up to 50 as the product of prime factors
 - determines the greatest common factor for pairs of numbers less than 50.
- Describes the meaning of terms related to the use of exponents (i.e., exponent, base, power, "squared", "cubed").
- Determines the value of a power, using whole number base and exponents of 2 and 3.
- Determines the square root of whole numbers, using estimation/square root tables/calculator.

Reads and interprets whole number calibrations on familiar meters, gauges and tools:

- kitchen/workshop measuring tools
- odometer
- air pressure gauge
- gas pump meter
- natural gas/electric/water meter.

Sequences and ranks whole numbers when:

- interpreting/displaying statistical data
- locating addresses/stadium seats
- locating information in the library.

Counts by multiples when quantifying:

- time on a traditional timepiece
- value of currency (coins or bills)
- chairs in the gym/cars in the parking lot
- total inventory on hand.

Uses the correct order for operations in answering skill-testing questions used in contests and promotions.

Reads and interprets distance charts and highway maps, calculating distances between cities.

Applies appropriate computational strategies (i.e., mental arithmetic, paper-and-pencil, calculator, estimation) in determining:

- materials required for construction and repair projects undertaken at home (e.g., number of tiles/bricks/panels/litres of paint/metres of trim)
- travel time and fuel consumption for given travel distances and travel rates.

Recognizes the use of exponential notation in describing familiar measurements:

- the school yard covers 2 square blocks
- the area of the room is 4 m^2
- $1 \text{ cm}^3 = 1 \text{ mL}$
- $1 \text{ ha} = 10\,000 \text{ m}^2$.

Uses square root in practical situations that involve length/distance:

- length of ladder required for a specific task
- distance across a field
- distance from home plate to second base.

Related Applications Across the Curriculum

English

Uses a variety of strategies to enhance comprehension when reading problems that involve whole number/decimal operations:

- uses context clues to determine meaning
- observes sequence of events
- identifies main idea and supporting details
- interprets visual/graphic information
- recognizes non-relevant detail.

Science

Uses knowledge of whole numbers and place value when:

- reading/interpreting calibrations on meters/gauges/scales
- gathering/interpreting statistical data
- using scientific formulas (e.g., mechanical advantage, heartbeat recovery rate)
- performing computations, using paper and pencil, mental arithmetic, estimation and the calculator.

Social Studies

Uses whole numbers when:

- relating employment opportunities to resource distribution
- comparing the remuneration offered for different types of work
- recording statistics about regional differences in Canada
- comparing global and national prices of goods.

Occupational Courses

Uses whole number computational skills in solving problems that involve:

- counting, calculating and recording movement of inventory
- reading and interpreting numbers on gauges/meters/scales.

Suggested Strategies/Activities

Investigate whole number concepts within the context of "real life" and work-related situations. The learning objectives outlined on the preceding page provide an overview of whole number skills that should be developed/reinforced through themes suggested in the *Teacher Resource Manual*.

Encourage students to discover whole number patterns and relationships throughout each theme by:

- exploring/experimenting
- simulating problem situations
- using the calculator
- working in small groups
- discussing/sharing ideas.

Provide frequent opportunities for the application of basic number skills. While most students may be able to recall the sums, differences, products and quotients for single-digit numbers, individuals who continue to experience difficulty with these will need to employ other strategies (e.g., calculator, tables, repeated additions/subtractions, finger math) in order to develop an understanding of process and consolidate needed computational skills.

Be aware that students often experience difficulty in understanding the abstract processes involved in:

- rounding beyond 10's and 100's (e.g., 1 000's, 10 000's, 100 000's)
- three-digit and four-digit subtraction that involves regrouping over a zero digit
- multiplication/division of numbers by 10 and multiples of 10
- multiplication when the multiplier contains zeros
- division containing zeros in the quotient
- division by two-digit divisors.

These concepts are frequently used in a variety of contexts, and some students may benefit from a review of related skills. Even at the high school level, manipulative materials are effective in helping students to internalize concepts (see *Teacher Resource Manual: Situational and Concrete Approaches*).

Avoid evaluation techniques that over-emphasize the use of paper-and-pencil algorithms. While these skills are important, evaluation should also assess student ability to:

- effectively use the calculator
- compute with mental arithmetic
- estimate computational results
- use concepts/skills in applications and problem solving.

LEARNING OBJECTIVES

Related Life Skills

DECIMALS

APPLIES DECIMAL SKILLS TO PRACTICAL PROBLEM SITUATIONS INVOLVING SEVERAL STEPS AND OPERATIONS.

- Uses previously developed decimal skills in progressively difficult and/or age-appropriate situations:
 - identifies place value to thousandths
 - reads decimals to thousandths
 - writes decimals in numeric form to thousandths
 - quantifies and orders numbers to three decimal places in applications
 - rounds decimals to the nearest whole number, tenth and hundredth
 - adds and subtracts decimals (limit for paper-and-pencil computation: numbers to thousandths)
 - multiplies decimals (limit for paper-and-pencil computation: numbers that yield products to thousandths, using one- or two-digit multipliers)
 - divides decimals (limit for paper-and-pencil computation: numbers having five digits or less by one- or two-digit divisors; dividend may have 0, 1, 2 or 3 decimal places, divisor may be a whole number or decimal)
 - uses mental arithmetic to determine products/quotients when multiplying/dividing by multiples of 10.
- Recognizes place value beyond the thousandths place in work-related situations (e.g., reading the micrometer).
- Rounds to the nearest thousandth/ten thousandth as required in work-related situations.

Reads meters, gauges and scales found in the home that are calibrated in tenths, hundredths and thousandths.

Establishes a practice of rounding calculations that represent money to the nearest hundredth (i.e., nearest cent).

Recognizes multistep problems that may require rounding to the nearest thousandth (or ten-thousandth) in order to maintain a degree of accuracy.

Multiplies/divides by multiples of 10 in converting metric units of measure.

Applies appropriate computational strategies (i.e., mental arithmetic, paper-and-pencil, calculator, estimation) in consumer-related situations:

- determines unit price/multiple price
- determines "best buy" by comparing the unit price of competing brands
- determines discount and sale price
- maintains a running total of the cost of items being selected for purchase
- determines the total cost of items purchased
- determines change due on purchases made
- checks the accuracy of sales-slip calculations.

Uses decimal skills as required in managing personal finances:

- completes banking forms/transactions (e.g., deposits/withdrawals, writes a cheque)
- determines interest on money saved or borrowed
- monitors gross earnings and net pay
- reconciles bank statements
- prepares a budget
- completes an income tax return.

Interprets decimal numbers beyond the thousandths place in practical situations:

- reading a micrometer
- reading utility meters/statements.

Related Applications Across the Curriculum

English

Recognizes the use of decimals in the Dewey decimal system.

Science

Reads and interprets decimal calibrations on meters, gauges and scales.

Uses decimals when interpreting/analyzing data obtained from observations/experiments.

Occupational Courses

Uses paper-and-pencil computation, mental arithmetic, estimation and the calculator to solve problems that involve:

- reading and interpreting numbers represented on meters, gauges and scales
- reading and interpreting numbers in the context of purchasing/selling/inventory control and in following formulas/recipes
- handling of billings, invoices and cash/credit transactions (e.g., prepares work orders, prepares bills for service, prepares bills of sale, makes change, balances cash receipts)
- calculating multiple costs (e.g., units $\times$ price = total cost). Checks calculations through estimation
- calculating unit cost (e.g., total cost $\div$ number of units = unit cost). Checks calculations through estimation
- calculating wages earned based on hourly, daily, weekly, monthly or annual schedules
- making financial plans/preparing budgets.

Suggested Strategies/Activities

Decimal skills should be developed and reinforced within the context of their application to themes suggested in the *Teacher Resource Manual*. For example, place value need only be studied to the hundredths' place when dealing with money in Budgeting and Banking. If examining the use of a micrometre in Math in the Workplace, it would be necessary to study place value to the thousandths' place.

While students should understand process and be able to use appropriate algorithms when the number of digits is small, calculators should be used on a regular basis in applications and problem solving that involve large numbers or tedious calculations. Assist students to interpret the multidigit decimals that may be displayed as the result of certain computations performed on the calculator. Estimation strategies must be developed and used in checking the reasonableness of answers obtained on the calculator.

Model techniques for mental arithmetic that include the use of compensation strategies and computing from left to right (see *Teacher Resource Manual: Computational Facility and Estimation*). Simulate consumer situations where students are required to use these techniques in mentally computing:

- the total cost of several items purchased
- change due, given amount offered in tender
- unit price/multiple price
- simple interest on small amounts of money
- their gross earnings.

Evaluation techniques should focus attention on student ability to use a variety of methods of computation in applications and problem solving (see *Teacher Resource Manual: Assessment/Evaluation*). While paper-and-pencil tests may be an effective way of evaluating some skills, assessment should also include:

- informal "demonstration" of understanding through discussion/project work
- observation of attitudes and performance
- participation in small group activities
- personal interviews.

LEARNING OBJECTIVES

Related Life Skills

FRACTIONS

DEMONSTRATES ABILITY TO USE BASIC FRACTION SKILLS IN PRACTICAL PROBLEM SITUATIONS (WITH EMPHASIS ON FRACTIONS HAVING DENOMINATORS OF 2, 3, 4, 5, 8, 10 AND 16).

- Applies previously developed fraction skills in progressively difficult and/or age-appropriate situations:
 - illustrates a fraction as part of a whole, part of a set, or a point on a number line
 - describes proper/improper fractions and mixed numbers through the use of objects, pictures and diagrams
 - using a number line, illustrates the relationship between whole numbers, decimals and fractions
 - compares and orders fractions in applications
 - identifies and determines equivalent fractions (including proper and improper fractions, mixed numbers)
 - identifies and expresses fractions in basic form
 - converts proper/improper/mixed fractions to decimals using a calculator
 - recalls decimal equivalents for one-half, thirds, quarters, fifths and tenths
 - determines common denominators for fractions having denominators of 2, 3, 4, 5, 8, 10 and 16
 - adds/subtracts fractions and mixed numbers having like/unlike denominators that are within the parameters stated above
 - multiplies/divides proper fractions and mixed numbers by whole numbers
 - calculates a fractional part of an amount in applications.
- Multiplies/divides proper fractions and mixed numbers by whole numbers/proper fractions.

Reads and interprets fractions represented on scales and gauges:

- inch ruler
- kitchen/workshop tools that measure capacity and mass
- fuel gauge.

Uses the inch unit in taking measurements for various construction/maintenance/repair projects in the home. Measures figures and objects to the nearest half, quarter, eighth and sixteenth of an inch.

Interprets fractional measurements provided on diagrams and blueprints. Finds missing dimensions by adding/subtracting fractional parts of an inch.

Follows recipes and directions that involve the use of fractional units of measure:

- two and three-eighth cups
- one and one-half teaspoons
- one-third of a package
- one-half of a block
- one-quarter of a turn.

Uses fraction skills in order to:

- describe a quantity or amount (e.g., two-thirds of a cup)
- make comparisons (e.g., two-year-olds are approximately $\frac{1}{2}$ of their adult height)
- interpret/use Imperial measure
- determine discount/sale price (e.g., one-third off)
- calculate gross pay (e.g., $37\frac{1}{2}$ hours at \$4.50/hour)
- calculate interest earned for fractional periods of time (e.g., \$1 000 invested at 10% for $1\frac{1}{4}$ years).

Adjusts recipes/patterns involving fractional units of measure:

- purchases enough material/accessories to make 2 shirts
- reduces a recipe for 8 servings to a recipe for 6 servings.

Related Applications Across the Curriculum

Suggested Strategies/Activities

Science

Reads/interprets fractional calibrations on measurement tools.

Uses fractions when:

- describing personal health and lifestyle factors (e.g., pulse rate, nutritional requirements)
- determining concentration of mixtures/solutions
- analyzing the mechanical advantage/efficiency of various labour-saving technologies.

Occupational Courses

Uses fraction concepts and computation in solving problems that involve:

- reading/interpreting calibrations on metric/Imperial measuring instruments
- modifying quantities of supplies/ingredients to suit variable needs (e.g., increasing/decreasing recipe ingredients, chemical mixes)
- reading charts to determine equivalent fraction-decimal sizes for mechanical fasteners and tools
- recognizing the size of various commonly used fasteners and tools (e.g., drill bits, wrenches, screws, nuts and bolts)
- reading and interpreting whole number, decimal and fractional measurements used in diagrams, blueprints, recipes and formulas.

The cognitive demands of concepts related to fractions make it necessary that instruction include the extensive use of manipulative and visual materials.

Structure activities through a "math lab" approach, giving each student the opportunity to manipulate materials and see tangible outcomes. De-emphasize activities that yield singular results through the application of computational rules not yet understood by students. Select activities that encourage students to:

- work with real models/pictures/diagrams
- experiment/explore
- ask questions
- verbalize ideas and discoveries
- make associations/draw conclusions.

Keep arithmetical computation simple, working only with fractions commonly encountered in real-life situations. Activities might be limited to work with the fractions included in the following families:

- $\frac{1}{2}$'s, $\frac{1}{4}$ th's, $\frac{1}{8}$ th's, $\frac{1}{16}$ th's
- $\frac{1}{2}$'s, $\frac{1}{3}$ rd's, $\frac{1}{6}$ th's
- $\frac{1}{2}$'s, $\frac{1}{5}$ th's, $\frac{1}{10}$ th's.

Demonstrate operations with fractions through concrete manipulation and diagrammatic representation. Translation to numbers and symbols should occur only after the processes have been understood. By asking appropriate chains of questions (see "Instructional Mediation"), students can be encouraged to discover relationships and generalize the results of their investigations.

The Imperial ruler offers many opportunities for students to reinforce/extend their understanding of fractions in a practical context. Measuring/drawing figures and objects to the nearest $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ and $\frac{1}{16}$ of an inch will enhance student ability to recognize order and equivalence among fractions. Operations can also be demonstrated on the ruler.

Strategies that support concept development through a "math lab" approach are provided in the *Teacher Resource Manual*: Situational and Concrete Approaches.

LEARNING OBJECTIVES

Related Life Skills

INTEGERS

**DEMONSTRATES ABILITY TO USE INTEGER SKILLS
WITHIN THE CONTEXT OF PRACTICAL SITUATIONS.**

- Applies previously developed integer skills in progressively difficult and/or age-appropriate situations:
 - identifies situations that require the use of integers
 - uses vocabulary related to integers (i.e., positive, negative, plus, minus, above, below gain, loss)
 - places integers on a number line
 - compares and orders integers in practical applications
 - adds pairs/groups of one- and two-digit integers.
- Adds/subtracts pairs of integers containing three digits or less.
- Multiplies/divides pairs of one- and two-digit integers (where multiplier and divisor are positive).
- Describes the use of integers in locating points on the coordinate plane.

Interprets temperatures both above and below zero. Determines temperature change.

Recognizes application of integers in score-keeping for games and sports:

- golf scores above and below par
- goals for and against in a hockey game
- yards gained and lost in football
- points gained and lost in a card game.

Uses integers in maintaining a bank account balance. Understands the concepts of an "overdraft" and "NSF cheque".

Recognizes the use of integers in describing:

- altitudes above and below sea level
- changes in the stock market
- time zone changes.

Related Applications Across the Curriculum

Suggested Strategies/Activities

Science

Applies integer skills in monitoring temperature and calculating temperature change.

Social Studies

Relates the use of integers to:

- importing/exporting goods
- calculating employment income and deductions.

Occupational Courses

Applies knowledge of integer concepts to situations that involve:

- reading and interpreting temperatures above and below zero
- calculating temperature change
- calculating profit and loss in production/service oriented activities (e.g., merchandising lab, hair and beauty services, automotive services)
- interpreting tolerances on various tools/gauges.

Integer concepts and skills should be developed within the context of their application to themes suggested in the *Teacher Resource Manual*. Encourage students to explore a variety of problem situations that require the use of integers:

- changes in the stock market
- keeping score in game situations
- debits and credits.

The abstract nature of integer operations makes it necessary that instruction involve the extensive use of manipulative and visual materials. Structure activities using a "math lab" approach, and encourage students to:

- work with real models/pictures/diagrams
- experiment/explore
- verbalize ideas and discoveries
- make associations/draw conclusions.

Demonstrate integer operations through concrete manipulation and diagrammatic representation (see *Teacher Resource Manual: Situational and Concrete Approaches*). Summarize the results of these investigations through the use of numbers and symbols. Encourage students to develop rules for each operation after the processes have been understood.

MATHEMATICS 26

RATIO, PROPORTION AND PERCENT

Students will be expected to demonstrate an understanding of ratio, proportion and percent, and use related concepts and skills in evaluating media claims and making informed decisions on buying, selling or investing. Instruction at the intuitive and concrete level will assist students to internalize concepts and apply related skills in real-life situations.

CONCEPTS

Students will be expected to demonstrate an understanding that:

- a ratio is a comparison of the relative sizes of two quantities
- a rate is a ratio between quantities that have different units
- proportions are statements about equivalent ratios
- percent is a ratio in which a quantity is compared to 100.

SKILLS

The skills relating to RATIO, PROPORTION AND PERCENT are outlined in the Learning Objectives listed in Column One on the following page.

ATTITUDES

Students will be encouraged to:

- display a positive attitude toward the application of concepts and skills in mathematics by
 - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
 - solving mathematical problems and completing assignments independently and in cooperation with others
- appreciate the usefulness of ratio, proportion and percent skills in solving consumer problems
- appreciate the importance of computational facility and critical thinking skills in evaluating information and making informed decisions in daily life and work-related situations.

LEARNING OBJECTIVES

Related Life Skills

DEMONSTRATES ABILITY TO USE RATIO, PROPORTION AND PERCENT SKILLS IN EVERYDAY APPLICATIONS AND PROBLEM-SOLVING SITUATIONS.

- Applies previously developed ratio, proportion and percent skills in progressively difficult and/or age-appropriate situations:
 - compares two quantities in the same unit by writing ratios in the form a/b , $a:b$ and a to b
 - generates equivalent ratios
 - calculates rates/unit rates by writing ratios that involve numbers with different units (e.g., 90 km/2h, 3 items for \$1.00)
 - identifies proportions as statements about equivalent ratios
 - writes proportions that describe practical problem situations
 - calculates the unknown value in a proportion.
 - expresses whole number percents as ratios/decimals
 - expresses ratios as decimals and percents (i.e.,
 $\frac{a}{b} = \frac{?}{100}$ where $b = 2, 4, 5, 10, 20, 25$ or 50)
 - recalls fraction, decimal and percent equivalents for one-half, quarters and tenths
 - expresses one-, two- and three-place decimals as percents
 - determines other fraction, decimal and percent equivalents through the use of the calculator
 - calculates/estimates a percent of a number.
- Using a calculator, converts fractional percents to fraction and decimal forms (e.g., $12\frac{1}{2}\% = \frac{1}{8} = 0.125$).
- Calculates/estimates what percent one number is of another.
- Calculates/estimates any one of the missing elements in practical problems involving application of percent (i.e., determines percentage, rate or base).

Recognizes travel rate as a comparison of distance travelled and time required for the journey.

Applies ratio skills to travel situations, recognizing the relationship between distance travelled, travel rate and travel time. Uses equivalent ratios to solve related problems.

Uses equivalent ratios in order to:

- determine unit cost and multiple cost of consumer items
- determine correct amount of solute and solvent for solutions
- interpret/construct scale drawings and models (e.g., maps, blueprints).

Interprets the meaning of percent in applications that relate to:

- discounts/sale prices
- price increase
- school marks
- interest on loans/charge accounts/savings accounts
- tax rates
- commissions.

Recognizes fractional and percent equivalents for discounts advertised on consumer items (e.g., a 25% sale means one-quarter off).

Estimates money saved and the sale price on an article when given the percent discount rate.

Calculates simple interest. Recognizes the effect of interest rate on the payback amount of a loan (or on interest accumulated from an investment).

Uses estimation in determining:

- interest from a bank account
- gross pay increase, given a wage increase of 3%.

Related Applications Across the Curriculum

Suggested Strategies/Activities

Science

Uses ratio/proportion skills in monitoring personal health (e.g., heartbeat recovery rates, nutritional content of foods).

Uses ratio/proportion/percent in recognizing the mechanical advantage and efficiency of various machines and technologies.

Uses knowledge of ratio and percent in interpreting data related to pollution factors.

Uses ratio in preparing chemical solutions and mixtures. Modifies quantities according to need.

Social Studies

Uses skills in ratio/proportion/percent when interpreting:

- scales provided on maps
- data related to topics that are investigated (e.g., employment trends, voting/survey results)
- charts, graphs and maps.

Occupational Courses

Uses ratio and proportion skills when:

- working with mixtures and solutions
- working with scale drawings or models
- constructing/applying gear and pulley systems
- increasing/decreasing recipes.

Calculates percent when:

- determining mark-up and selling price
- determining discount and sale price
- measuring profit or loss.

Calculates profit and loss as a percent. Recognizes the relationship between percent profit and entrepreneurial success.

It is often assumed that high school students understand the concepts of ratio, proportion and percent because they have been exposed to these ideas throughout their school experience. This may not be the case, and care must be taken to develop and reinforce these concepts through meaningful activities. Diagnose areas of student strength/weakness, and plan remedial activities that provide concrete and visual experiences for students.

Keep number relationships simple, and emphasize relevant applications rather than tedious computation. Develop concepts through familiar applications that involve:

- discount/mark-up
- scale drawings
- pay cheque deductions
- interest
- unit pricing/multiple pricing
- gear ratios
- wage rates/commissions
- rate of travel/speed
- growth rates.

Relate calculations that are performed to "real life" situations. Collect newspaper articles or sale flyers that use ratio and percent (e.g., 1/3 discount, 25% increase, 10% interest) and simulate situations that require the application of related concepts and skills.

Students should recognize that numbers have different equivalent forms (e.g., fraction, decimal and percent). Model the use of appropriate mental arithmetic strategies in determining fraction, decimal and percent equivalents that are frequently used.

Encourage students to develop strategies for solving proportions and finding percent by investigating a variety of concrete representations (see *Teacher Resource Manual: Situational and Concrete Approaches*). The "cross-product" method of solving proportions should be developed and used after students have experience in solving proportions using the common multiple/common factor methods.

Once processes are understood, students should use the calculator in applications and problem solving. Provide instruction on using the percent key, and model the sequence of entries that are made in performing routine calculations with ratio and percent. Emphasize the use of estimation in checking the results of computation.

Maintain/extend mental arithmetic and estimation skills by providing frequent opportunity for oral work:

- 50% of \$12.50
- a \$20.00 shirt discounted by 10%
- 15 out of 20 = ____%.

MATHEMATICS 26

ALGEBRA

Instruction should focus attention on the use of number patterns, relationships and logical thinking skills to make predictions and to solve problems. Students will be expected to generalize arithmetical patterns and relationships that are present in concrete situations, and to write expressions/equations that describe the patterns and relationships they discover. Students will use substitution and equation-solving strategies to solve "real life" and work-related problems involving familiar number patterns and relationships.

CONCEPTS

Students will be expected to demonstrate an understanding that:

- arithmetical patterns and relationships are present in a variety of practical everyday situations, and are useful in enabling us to draw conclusions and make predictions
- algebraic symbols can be used to write expressions/formulas/linear equations that describe familiar arithmetical patterns and relationships
- substitution and equation-solving strategies are useful in solving practical problems, and involve application of number properties and operations.

SKILLS

The skills relating to **ALGEBRA** are outlined in the Learning Objectives listed in Column One on the following page.

ATTITUDES

Students will be encouraged to:

- display a positive attitude toward the application of concepts and skills in mathematics by
 - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
 - solving mathematical problems and completing assignments independently and in cooperation with others
- appreciate the usefulness of algebra in describing arithmetical patterns and relationships that are present in practical situations, as well as in solving daily life and work-related problems.

LEARNING OBJECTIVES

Related Life Skills

DEMONSTRATES ABILITY TO USE ALGEBRA SKILLS WITHIN THE CONTEXT OF EVERYDAY AND WORK-RELATED SITUATIONS.

- Applies previously developed algebra skills in progressively difficult and/or age-appropriate situations:
 - distinguishes between the use of variables and constants in practical situations
 - uses variables to write mathematical expressions/equations that describe familiar situations
 - evaluates expressions for given whole number values of the variable
 - uses estimation, guess/check, concrete manipulatives and formal strategies to find whole number solutions for simple equations (e.g., $x \pm a = b$, $ax = b$, $x/a = b/c$, $ax \pm b = c$)
 - applies equation-solving skills to practical problem situations
 - interprets formulas as word statements
 - uses formulas and substitution to solve problems in practical situations (e.g., if $P = 2L + 2W$, find P when $L = 10$ and $W = 8$).
- Evaluates expressions for given decimal values of the variable.
- Uses estimation, guess/check, concrete manipulatives and formal strategies to find decimal solutions for simple equations (e.g., $x \pm a = b$, $ax = b$, $x/a = b/c$, $ax \pm b = c$).
- Applies equation-solving strategies/skills to practical situations involving decimals.
- Uses substitution and equation-solving strategies to find the missing element in a formula (e.g., if $P = 2L + 2W$, find L when $P = 16$ and $W = 3$).

Recognizes number patterns and relationships that are present in practical situations:

- home decorating/maintenance/repair
- personal finance/management
- travel/sport/recreation.

Interprets simple linear equations/formulas that describe number patterns and relationships present in familiar situations. Relates equations/formulas to word statements about the situation:

- $A = 1w$
- $V = 1wh$
- $I = prt$
- $A = P + I$
- $d = rt$.

Rearranges the parts of a formula to fit a practical situation:

- if $d = rt$, then $r = d/t$
- if $A = P + I$, then $P = A - I$.

Uses equations/formulas to solve routine problems that involve previously established number patterns and relationships. Problem situations may involve:

- gross pay, deductions and net pay
- calculation of interest
- unit price and multiple price
- discount and sale price
- mark-up and selling price
- scale drawings
- perimeter/area/volume
- conversion among units of measure
- adjustments to recipes/directions
- travel (i.e., distance, rate, time).

Related Applications Across the Curriculum

Science

Writes equations that describe numerical relationships discovered through scientific investigation.

Performs substitution into formulas as required in order to solve problems.

Social Studies

Uses algebraic notation to describe:

- population, employment and economic trends
- Canada's contribution to world markets.

Occupational Courses

Uses formulas/equations to solve problems that involve:

- food requirements for a variable number of people
- stock requirements based on past sales
- conversions among units of measure
- relationships among travel distance, rate of travel and travel time
- adjusting recipes/mixtures according to need
- profit/loss in entrepreneurial activities.

Suggested Strategies/Activities

Plan activities that will assist students to apply number patterns, relationships and logical thinking skills within the context of themes provided in the *Teacher Resource Manual*. Instruction should foster an understanding of:

- number patterns/relationships that are present in "real life" situations
- the use of variables in generalizing patterns, as abbreviations in formulas, and as unknowns in problems
- appropriate strategies for evaluating expressions/formulas that describe practical situations
- both informal and formal strategies for solving simple equations.

A structured worksheet is often effective in helping students to cope with the cognitive demands of algebraic representation and equation solving. The structure and organization provided by a worksheet may clarify complexities of a problem, and also prompt students to use appropriate strategies in correct sequence. A sample format for a problem-solving worksheet is provided in the *Teacher Resource Manual: Problem Solving*.

Provide frequent opportunities for students to:

- generalize numerical patterns and relationships by constructing tables. Look for patterns, and write expressions that describe the patterns
- evaluate expressions/formulas that describe problem situations by using a variety of strategies (e.g., mental arithmetic, formal substitution, calculator, computer programs).

Relate "guess and check" strategies for solving equations to finding numbers that balance the left and right sides of the equation. Emphasize the need to organize work and document processes used through formal substitution procedures.

Example: Solve $2n + 3 = 15$
Try $n = 5$ $2(5) + 3 = 13$ (too small)
Try $n = 8$ $2(8) + 3 = 19$ (too big)
Try $n = 6$ $2(6) + 3 = 15$ (just right)

Encourage the use of the calculator (and the automatic constant function) as an aid to the process of finding solutions by guess/check.

Assist students to develop "formal" strategies for solving equations by comparing the process to:

- maintaining balance on a scale (e.g., a number added to one side of the equation must also be added to the other side)
- packing and unpacking boxes (e.g., reversing operations and the order in which they are performed).

Equation-solving strategies of this nature are described in further detail in the *Teacher Resource Manual: Problem Solving*.

MATHEMATICS 26

GEOMETRY AND MEASUREMENT

Instruction will focus attention on developing spatial and visualization skills, and an understanding of how measures are used to quantify and interpret the world. Students will be expected to demonstrate an understanding of the attributes/properties of familiar one-, two- and three-dimensional geometric figures, and to apply related patterns/relationships in solving real-life and work-related problems. Students will also be expected to estimate and measure length, area, volume, capacity, mass, time, temperature and angles in order to solve problems and make predictions.

It is the policy of Alberta Education that SI units be the principal system of measurement in the curriculum of the schools in the province. The study of specific Imperial units should be related only to those that are relevant to student needs (as indicated by the demands of the workplace/ community partnership sites) and should be kept to a minimum.

CONCEPTS

Students will be expected to demonstrate an understanding that:

- geometry is a visual approach to organizing and interpreting our perceptions of the environment and physical world
- there are basic concepts, patterns and relationships associated with one-, two- and three-dimensional geometric figures
- the selection of units and tools of measurement must always be based upon the physical attributes of the object being measured
- estimation and measurement are iterative and comparative in nature
- a mental frame of reference is useful in establishing the size of standard units of measure, relative to each other and to real objects
- geometry and measurement contribute to the problem-solving process, and have application in activities we engage in as citizen, consumer and worker.

SKILLS

The skills relating to **GEOMETRY AND MEASUREMENT** are outlined in the Learning Objectives listed in Column One on the pages that follow.

ATTITUDES

Students will be encouraged to:

- display a positive attitude toward the application of concepts and skills in mathematics by
 - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
 - solving mathematical problems and completing assignments independently and in cooperation with others
- appreciate how geometry and measurement provide us with methods for gathering and organizing information about the physical world
- appreciate the ways in which geometry and measurement affect our daily activities and contribute to the problem-solving process.

LEARNING OBJECTIVES

Related Life Skills

GEOMETRY

**DEMONSTRATES ABILITY TO APPLY GEOMETRY SKILLS
IN DAILY LIFE AND WORK-RELATED SITUATIONS.**

- Applies previously developed geometry skills in progressively difficult and/or age-appropriate situations:
 - identifies line relationships (i.e., horizontal, vertical, parallel, perpendicular and intersecting)
 - identifies/constructs basic two-dimensional geometric figures (i.e., rectangle, square, parallelogram, triangle)
 - classifies triangles and quadrilaterals by examining measures of sides and measures of angles
 - identifies the relationship between the radius and diameter of a circle
 - constructs circles, given either radius or diameter
 - identifies similar and congruent geometric figures
 - identifies/sketches/constructs models of basic three-dimensional shapes (i.e., rectangular solid, cube, cylinder, cone)
 - constructs geometric figures/designs, using a variety of construction tools (i.e., straightedge, ruler, compass, protractor, computer).
- Identifies/classifies polygons according to the number of sides (limit: octagon).
- Constructs regular polygons (i.e., triangle, square, hexagon, octagon).
- Describes the terminology associated with the coordinate system (i.e., origin, axis, quadrant, coordinates, ordered pair).
- Plots a point on the coordinate plane when given its coordinates, and identifies the coordinates for a point graphed in the coordinate plane.

Recognizes/appreciates geometric form found in:

- the natural environment
- architecture
- floor coverings/fabrics/wallpaper.

Interprets/uses line relationships when reading road maps and giving travel directions.

Recognizes geometric shapes and relationships that are used:

- on traffic signs
- as symbols on maps
- on clothing care labels
- on hazardous materials/warning labels.

Applies knowledge of geometric figures and relationships when interpreting/constructing:

- scale diagrams (e.g., floor plans, maps)
- graphs and charts
- patterns and designs.

Interprets three-dimensional objects that have been represented by a sketch:

- recognizes perspective
- relates front, side and top views.

Enlarges or reduces patterns/scale drawings required for a project through the use of:

- dot paper/grid paper
- measurement and ratio.

Uses geometric figures/relationships in designing various home and hobby projects. Plans the project by constructing a scale drawing or model.

Relates use of the coordinate plane to practical situations:

- interpreting road maps
- giving travel directions
- interpreting navigational directions (e.g., N30°W)
- using the atlas (e.g., longitude and latitude).

Related Applications Across the Curriculum

English

Uses a variety of skills and strategies to follow instructions when constructing designs or scale drawings:

- recognizes the need to follow specific sequence
- listens to and interprets verbal instructions
- interprets diagrams, signs, symbols and written instructions.

Science

Recognizes/appreciates geometric patterns occurring in the natural environment.

Social Studies

Applies concepts of one-, two- and three-dimensional geometry when:

- identifying national, provincial and municipal voting jurisdictions
- locating specific addresses on a rural/urban grid system
- preparing/interpreting scale drawings/maps.

Occupational Courses

Uses geometric concepts/skills when completing projects in:

- construction/repair/maintenance
- craft work/artwork/graphic arts
- hair care/esthetology
- horticulture.

Uses appropriate geometric tools in preparing scale drawings and completing projects.

Suggested Strategies/Activities

Instruction should emphasize the development of spatial and visualization skills as they are used to interpret and organize our three-dimensional world. Develop knowledge of geometric figures/relationships by modelling various aspects of the physical world, and by providing frequent opportunities for work with concrete materials.

Teaching strategies that are inductive and experimental will assist students to recognize patterns and develop an understanding of the more abstract concepts in geometry. Plan activities that involve observation, manipulation, construction, informal reasoning and the use of problem-solving skills. Students should make frequent use of tools that will aid their geometric explorations (e.g., compass, protractor, straightedge, squared paper, the computer).

Concepts of one-dimensional space are usually well understood. Students find two-dimensional and three-dimensional concepts more difficult, and may require concrete support for successful experience in these areas. Manipulation and construction become increasingly important in helping students to recognize the spatial relationships inherent in these figures.

Provide opportunities for students to construct geometric patterns/designs/logos using a variety of tools and techniques. These activities reinforce the geometric concepts under investigation, develop facility in the use of construction tools, and provide meaningful application of skills in linear and angle measure. Encourage students to be creative. Display student work in colourful and attractive arrangements.

Although geometry and visualization skills are used in a variety of work-related tasks, much more knowledge is needed in occupations such as plumbing, carpentry, forestry, interior decorating and drafting. Discuss your geometry and measurement unit with teachers of other programs. Plan projects in which students can apply related skills.

Sample activities that may assist students to develop skills in visual perception are provided in the *Teacher Resource Manual*: Situational and Concrete Approaches. Activities include the use of:

- geoboards/dot paper/grid paper
- tangrams/tessellations
- LOGO computer programs
- line design/model construction
- puzzles/problems.

LEARNING OBJECTIVES

Related Life Skills

LENGTH

DEMONSTRATES ABILITY TO USE APPROPRIATE UNITS AND TOOLS TO ESTIMATE AND MEASURE LENGTH IN DAILY LIFE AND WORK-RELATED SITUATIONS.

- Applies previously developed skills when measuring length in progressively difficult and/or age-appropriate situations:
 - identifies common SI units of length (i.e., mm, cm, m, km)
 - estimates/measures length, using metric units and tools appropriate to the situation
 - converts among SI units of length as required in applications
 - estimates/measures/calculates the perimeter of figures bounded by line segments using units and tools appropriate to the situation
 - identifies the value of π as the ratio of the circumference of a circle to its diameter
 - develops/applies strategies for determining the circumference of a circle.
- Develops/applies strategies for determining the perimeter of any regular polygon.
- Describes the Pythagorean relationship among sides of a right triangle, and applies the relationship to practical situations.

- E ● Identifies common Imperial units of length (e.g., inch, foot, yard, mile).
- E ● Estimates and measures length, using Imperial units and tools appropriate to the situation.
- E ● Compares cm to inch, m to yard and km to mile.

Reads/interprets scales on rulers and tape measures.

Uses estimation skills in approximating the length of familiar household and consumer items.

Takes body measurements, using tools and units appropriate to the task. Relates personal measurements to clothing size.

Uses skills of estimation and measurement in determining materials required for various decorating, construction and repair projects.

Converts units of measure as required in determining the cost of consumer materials sold by length (e.g., 75 cm of fabric at a cost of \$15.98/m).

Develops a "frame of reference" for the kilometre, and relates familiar travel distances to the kilometre.

Uses the Pythagorean theorem in practical situations that involve determining length/distance:

- length of a ladder required for a specific purpose
- distance across a rectangular field.

Related Applications Across the Curriculum

Science

Uses linear measurement skills when:

- collecting data from scientific investigations
- constructing simple models/technologies in project work.

Social Studies

Uses units/tools of linear measure when:

- estimating/calculating distances on a map
- drawing a map to scale
- developing bar/line graphs that display information.

Occupational Courses

Reads scales on rulers, tape measures and other measuring devices when building a product or providing a service.

Recognizes and applies concepts of length/perimeter/circumference in projects related to:

- construction trades
- agriculture/horticulture
- window display projects
- hair care/esthetology.

Converts among units of length as required in practical situations.

Suggested Strategies/Activities

Measurement skills can be developed more successfully if estimation is a content objective. Provide opportunities for students to develop skill in making reasonable estimates before engaging in activities that involve actual measurement and precision. Consider the following guidelines when planning activities in estimation and measurement:

- develop skill in estimation by having students make an estimate and then check their estimate through direct measurement
- although some experience in direct measurement may immediately follow the introduction of a particular unit, only a few measurements of this nature should be taken before students are asked to make estimates prior to performing direct measurement
- encourage good estimates, but do not provide penalties for inaccurate ones
- the ability to estimate is based on previous experience and must be practised on a regular basis throughout the program.

Measurement should be a "doing" kind of mathematics, where relevant activity gives meaning to skills that are being developed. Relate instruction to everyday situations where linear measurement is used to solve problems and to make predictions. Activities may involve:

- determining appropriate clothing size according to body measurements
- estimating distances travelled in the community
- selecting appropriate home furnishings on the basis of measurements that have been taken
- interpreting/constructing scale diagrams and models.

Review standard units of length through the use of referents and visual imagery:

- mm (width of a dime)
- cm (width of little finger)
- m (width of a table)
- km (distance between two familiar points).

Business and industry have reached varying states in their conversion from Imperial units to metric units. Some occupations/life skills still require the use of Imperial units. Community needs will determine the extent to which elective content dealing with Imperial measure will be developed. If developed, students should compare only, and not convert corresponding units from the Imperial system to the metric system:

- "Is three metres of fabric more than three yards of fabric?"
- "Is my waistline measurement 30 inches or 30 cm?"

LEARNING OBJECTIVES

Related Life Skills

AREA

DEMONSTRATES ABILITY TO USE APPROPRIATE UNITS AND TOOLS TO ESTIMATE AND MEASURE AREA IN DAILY LIFE AND WORK-RELATED SITUATIONS.

- Applies previously developed skills when measuring area in progressively difficult and/or age-appropriate situations:
 - identifies common SI units of area (i.e., cm^2 , m^2) and their application in practical situations
 - approximates the area of two-dimensional geometric figures using a square grid
 - estimates/calculates area of the rectangle, square, triangle and circle, using units, tools and strategies appropriate to the situation.
- Develops/applies appropriate strategies for determining the surface area of rectangular solids and cylinders.

VOLUME

DEMONSTRATES ABILITY TO USE APPROPRIATE UNITS AND TOOLS TO ESTIMATE AND MEASURE VOLUME IN DAILY LIFE AND WORK-RELATED SITUATIONS.

- Applies previously developed skills when measuring volume in progressively difficult and/or age-appropriate situations:
 - identifies common SI units of volume (i.e., cm^3 , m^3) and their application in practical situations
 - approximates the volume of rectangular solids using cubes
 - estimates/calculates the volume of rectangular solids and cubes, using units, tools and strategies appropriate to the situation.
- Identifies the equivalence between cubic centimetres and millilitres.
- Develops/applies appropriate strategies for determining the volume of right cylinders.

Uses estimation/measurement/calculation in determining surface area and quantity of materials required for various maintenance projects around the home:

- painting
- carpeting
- wallpapering
- tiling.

Interprets product labels that relate "rate of application" to area:

- lawn seed and fertilizer
- paint.

Develops a strategy for determining the amount of material required to cover a rectangular solid or cylinder:

- gift wrap for a box
- paint for a cylindrical storage tank.

Recognizes the use of volume measure in describing:

- engine size
- size of storage containers
- refrigerator/freezer size
- utilities consumed (e.g., natural gas, water).

Determines the volume of concrete required for simple construction projects at home.

Estimates/calculates the volume of containers frequently used around the home:

- storage boxes
- refrigerator/freezer.

Interprets product labels that relate "rate of application" to volume measure:

- fertilizers/growth supplements
- medications.

Related Applications Across the Curriculum

Science

Acknowledges the relationship between millilitres and cubic centimetres.

Uses area/volume measure as required in gathering/interpreting data for scientific investigations.

Social Studies

Uses appropriate strategies to calculate area when comparing the population density of municipal, provincial and national jurisdictions.

Occupational Courses

Recognizes appropriate units and strategies for calculating area and volume.

Calculates area and volume in order to determine materials needed to produce a product or provide a service:

- construction projects
- agriculture/horticulture projects
- maintenance tasks
- hair care and esthetology services
- crafts, arts and graphic projects.

Suggested Strategies/Activities

Students may require concrete support in order to internalize the two-dimensional concept of area and the three-dimensional concept of volume. Incorporate the use of manipulative and pictorial materials in learning activities. Materials used may include:

- tiles/grid paper
- cubes/models.

Encourage students to develop "mind pictures" for the square centimetre, square metre, cubic centimetre and cubic metre. Have students construct these units.

Area and volume formulas should be developed as a consequence of patterns/relationships that have been discovered through manipulation and construction. Assist students to deduce their own strategies for determining area and volume that are based on the results of investigation.

Distinguish between area (surface covered) and volume (space occupied). Illustrate the difference by referring to practical situations and identifying the concept involved:

- "How much carpet do we need?"
- "How much concrete do we need?"

Model the use of pictures/diagrams as a strategy for problem solving.

Additional suggestions for developing area and volume concepts are provided in the *Teacher Resource Manual: Situational and Concrete Approaches*. Relevant applications of area and volume have been included throughout themes developed for the mathematics program.

Consult with occupational teachers in order to identify measurement skills that are used by students in these courses. Provide opportunities for students to develop and apply related skills in mathematics class.

LEARNING OBJECTIVES

Related Life Skills

CAPACITY

DEMONSTRATES ABILITY TO USE APPROPRIATE UNITS AND TOOLS TO ESTIMATE AND MEASURE CAPACITY IN DAILY LIFE AND WORK-RELATED SITUATIONS.

- Applies previously developed skills when measuring capacity in progressively difficult and/or age-appropriate situations:
 - identifies common SI units of capacity (i.e., mL, L) and their application in practical situations
 - estimates and measures capacity, using metric units and tools appropriate to the situation
 - converts between mL and L.
- E ● Identifies common Imperial units of capacity (e.g., teaspoon, tablespoon, cup, quart, gallon).
- E ● Estimates and measures capacity, using Imperial units and tools appropriate to the situation.
- E ● Compares mL and L to cups, also L to quarts/gallons.

MASS

DEMONSTRATES ABILITY TO USE APPROPRIATE UNITS AND TOOLS TO ESTIMATE AND MEASURE MASS IN DAILY LIFE AND WORK-RELATED SITUATIONS.

- Applies previously developed skills when measuring mass in progressively difficult and/or age-appropriate situations:
 - identifies common SI units of mass (i.e., g, kg, t) and their application in practical situations
 - estimates and measures mass, using metric units and tools appropriate to the situation
 - converts between g and kg and between kg and t.
- E ● Identifies common Imperial units of mass (e.g., ounce, pound).
- E ● Estimates and measures mass, using Imperial units and tools appropriate to the situation.
- E ● Compares kg to pound.

Reads and interprets scales on familiar measuring tools:

- kitchen/supermarket weight scale
- capacity measures used in the kitchen/workshop.

Uses estimation skills when:

- discriminating between objects of "greater" and "lesser" capacity/mass
- approximating the capacity/mass of familiar household and consumer items.

Selects items for purchase that are sold by capacity/mass. Estimates and measures consumer items in relation to these attributes, using units and tools appropriate to the situation.

Interprets product labels that relate "rate of application" to capacity/mass.

Converts units of measure as required when:

- adjusting recipes/directions that involve measure of capacity/mass
- determining unit price and "best buy" for consumer items sold by capacity/mass
- determining the cost of materials sold by capacity/mass (e.g., 250 g of meat at \$4.98 per kg).

Uses capacity measure when:

- cooking
- taking medications.

Monitors personal weight, using appropriate units and graphing skills.

Related Applications Across the Curriculum

Suggested Strategies/Activities

Science

Estimates/measures capacity and mass in a variety of inquiry-related activities:

- measures chemical substances by capacity and mass
- prepares mixtures/solutions using appropriate measures of capacity and mass
- measures force/mass when investigating simple technologies.

Occupational Courses

Uses appropriate units and tools for measuring capacity and mass when:

- following recipes
- preparing mixtures/solutions
- purchasing goods by capacity or weight.

Converts between units as required.

Review standard units of capacity/mass through the use of referents and visual imagery:

- mL (amount of liquid in an eyedropper)
- L (amount of milk in a carton)
- g (mass of a raisin)
- kg (mass of a pair of shoes).

Useful strategies for making estimates of capacity/mass may include:

- comparing the whole object to be estimated with a familiar object of known size
- using a referent of known size and mentally or physically marking-off/filling the object to be estimated.

Be sure to accept a range of estimates, and encourage students to share the strategies they use in making their estimates.

Sequence activities so that students can improve the accuracy of the estimates they are making. Record a "+" each time an estimate is larger than the corresponding measurement, and a "-" each time the estimate is smaller. Students who consistently have pluses (minuses) will then realize that they need to adjust their estimates by making them smaller (larger).

Relate instruction to everyday situations where measures of capacity and mass are used to solve problems/make predictions:

- estimating the capacity of kitchen/workshop containers of varying size and shape
- estimating the mass of familiar bulk/packaged supermarket and hardware items
- following recipes/directions that involve measures of capacity/mass.

Community needs will determine the extent to which elective content dealing with Imperial measure will be developed. If developed, students should compare only and not convert corresponding units from the Imperial system to the metric system:

- Does a one-gallon container hold more than a one-litre container?
- Is a 5-kg bag of apples larger than a 5-pound bag of apples?

LEARNING OBJECTIVES

Related Life Skills

TIME

DEMONSTRATES ABILITY TO USE APPROPRIATE UNITS AND TOOLS TO ESTIMATE AND MEASURE TIME IN DAILY LIFE AND WORK-RELATED SITUATIONS.

- Applies previously developed skills when measuring time in progressively difficult and/or age-appropriate situations:
 - uses a calendar, recognizing the relationship between days, weeks, months and years
 - uses accepted standards for numeric dating
 - estimates/measures/records time on the 12-hour and 24-hour clocks, using traditional and digital time pieces
 - determines the interval between a pair of times
 - determines the finishing time, given the starting time and duration.

TEMPERATURE

DEMONSTRATES ABILITY TO ESTIMATE AND MEASURE TEMPERATURE IN DAILY LIFE AND WORK-RELATED SITUATIONS.

- Estimates/measures temperature on the Celsius scale.
 - Recalls important temperatures on the Celsius scale (i.e., boiling/freezing point of water, normal room/body temperature).
 - Determines temperature change, including changes from below zero to above zero and vice versa.
- E ● Estimates and measures temperature on the Fahrenheit scale.
- E ● Compares Fahrenheit and Celsius temperature.

ANGLE

DEMONSTRATES ABILITY TO USE APPROPRIATE UNITS AND TOOLS TO ESTIMATE AND MEASURE ANGLES IN DAILY LIFE AND WORK-RELATED SITUATIONS.

- Applies previously developed skills when measuring angles in progressively difficult and/or age-appropriate situations:
 - identifies an angle and the degree as a unit of measure
 - identifies/estimates angles of 30°, 45°, 60°, 90°, 180° and 360°
 - uses a protractor to measure and draw angles from 0° to 180°
- Uses a protractor to measure and draw angles from 0° to 360°.
- Applies knowledge of the sum of the angles of a triangle in practical situations.

Uses calendar and numeric-dating skills in a variety of everyday situations:

- recognizes due dates on bills/library books
- dates letters/cheques/application forms appropriately
- identifies current and post-dated cheques.

Reads and interprets 24-hour time stated on:

- train/bus/airplane schedules
- traffic/parking signs.

Records start and finish times for tasks undertaken. Accurately determines/measures time intervals:

- determines cooking/baking times
- sets time-bake oven/video recorder
- determines hours and minutes worked.

Recognizes that the type of thermometer used must be appropriate to the range of temperatures being measured. Interprets the scale on various types of thermometers:

- oven thermometer
- hospital thermometer
- refrigerator/freezer thermometer.

Monitors body temperature in times of illness.

Converts cooking temperatures from Celsius to Fahrenheit (and vice versa) through the use of a chart.

Recognizes angle relationships used in practical everyday situations. Appreciates their use in construction and design.

Applies skills of angle measure when:

- giving or following directions on a map
- reading a compass
- interpreting/constructing scale drawings
- constructing patterns/designs.

Related Applications Across the Curriculum

Suggested Strategies/Activities

Occupational Courses

Maintains personal record of attendance and punctuality for classroom activities and field experiences:

- time-in/time-out
- hours worked
- time of telephone contacts
- record of appointments.

Measures intervals of time required for various processes/procedures:

- cooking/baking time
- drying time
- curing time.

Selects and reads temperature gauges appropriate to the task:

- indoor thermometer
- oven thermometer
- medical thermometer
- meat thermometer
- refrigerator/freezer thermometer

Recognizes temperatures appropriate to:

- storing food/materials
- working environment
- efficient engine operation.

Applies skills of estimation and measurement when working with angles in a variety of occupational areas:

- drafting/graphic arts
- haircutting
- window display
- crafts and arts
- construction fields.

Maintain skills in time measure by incorporating the use of the calendar, stopwatch, digital clock, and traditional 12-hour and 24-hour clocks into daily activities.

Develop ability to estimate time by:

- comparing time intervals to the duration of a familiar event (e.g., length of a song)
- providing opportunities for students to estimate both active and passive periods of time.

Projects involving time measure are provided in themes included in the *Teacher Resource Manual*, and require students to use:

- personal time schedules/time cards
- travel/telecast schedules.

Investigate special purpose thermometers used by students in their occupational courses. Examine the calibrations on different thermometer scales:

- How do numbers on the scale increase in size?
- How many intervals are there between numbers on the scale?
- How many degrees does each interval represent?

Local needs will determine the extent to which elective content dealing with the Fahrenheit thermometer will be developed. If developed, emphasis should be placed on the comparison (not conversion) of temperatures on the Fahrenheit and Celsius scales. Students should recognize the use of "temperature conversion charts" in "real life" situations that require an exact conversion of temperature.

Identify examples of angles found in the environment. Relate angles of 45°, 90°, 180° and 360° to physical models that are familiar to the student.

Provide opportunities for students to estimate angle measure, and to check estimation through actual angle measure with a protractor. Instruction on the use of the protractor should include discussion of:

- the purpose of the inside and outside scale
- strategies to follow in measuring angles greater than 180°.

Develop skill in angle measure by constructing geometric figures, patterns/designs and scale drawings.

MATHEMATICS 26

DATA INTERPRETATION AND DISPLAY

Students will be expected to demonstrate an understanding that numerical data collected from a sample must be organized, displayed and analyzed in order that valid inferences can be drawn. Students will develop strategies for collecting, organizing, displaying and interpreting numerical data in a variety of practical situations, and for predicting probable outcomes based on data that has been collected. As students perform related experiments, they will develop ability to think consistently about arguments, justify their thinking with numerical information, and cope with uncertainty.

CONCEPTS

Students will be expected to demonstrate an understanding that:

- throughout life, many decisions are based on numerical data
- a variety of procedures can be used to collect, organize and display numerical data
- data collected from a sample must be organized, displayed and analyzed in order that valid inferences can be drawn and predictions made
- probability provides a way to measure uncertainty
- statistical measures are useful in summarizing large quantities of numerical data, in communicating ideas and in predicting future outcomes or actions.

SKILLS

The skills relating to **DATA INTERPRETATION AND DISPLAY** are outlined on the Learning Objectives listed in Column One on the following page.

ATTITUDES

Students will be encouraged to:

- display a positive attitude toward application of concepts and skills in mathematics by
 - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
 - solving mathematical problems and completing assignments independently and in cooperation with others
- appreciate the need to interpret and evaluate statistical data provided through the media
- appreciate how statistics and probability may assist the decision-making process in consumer and work-related situations.

LEARNING OBJECTIVES

Related Life Skills

COLLECTS, ORGANIZES, DISPLAYS AND ANALYZES NUMERICAL DATA IN ORDER TO DRAW VALID INFERENCES AND MAKE INFORMED DECISIONS IN EVERYDAY SITUATIONS.

- Applies previously developed statistical skills in progressively difficult and/or age-appropriate situations:
 - distinguishes between a survey and census, also between a sample and population, identifying potential biases that may occur in surveys and samples
 - interprets and analyzes data presented in tables/charts and bar/line/picture/circle graphs
 - displays data in the form of tables/charts and bar/line/picture/circle graphs
 - identifies the characteristics of a misleading graphical display
 - determines/calculates appropriate measures of central tendency in practical situations (i.e., mean, median, mode, range)
 - conducts a survey or poll, using appropriate methods of gathering, organizing, presenting and analyzing data.
- Explains the meaning of "probability" and gives examples of its use in today's society.
- Uses counting techniques such as tree diagrams/charts to determine the number of ways that an event can happen.
- Expresses the probability of the occurrence of a single event related to a practical experience or a simple experiment.

Reads/interprets/analyzes information provided in newspapers and magazines that has been displayed in table/chart/graph form.

Recognizes how statistics are used in everyday situations:

- weather reports (e.g., probability of precipitation)
- consumer reports (e.g., average price of an item)
- opinion polls (e.g., popularity of a television program or political figure)
- performance in sports (e.g., batting average)
- personal development (e.g., average height/weight charts)
- health risks (e.g., frequency of lung cancer in smokers)
- lottery outcomes (e.g., odds of winning the jackpot).

Uses appropriate measures of central tendency in describing:

- test marks/school achievement
- achievement in sports
- income over several weeks/months.

Recognizes potential biases that may be present in the results of surveys/polls used in advertising:

- 2/3 of the people interviewed preferred Brand X
- 8 out of 10 people felt that the clothes washed by ___ came out whiter.

Recognizes the frequent use of probability in "real life" situations:

- your chances of being hit by lightening are greater than winning the lottery
- there is a 60% chance of rain
- you have a 50-50 chance of drawing "heads" when tossing a coin.

Related Applications Across the Curriculum

English

Reads/interprets information presented in tables, charts and graphs.

Interprets statistical data as required in research activities.

Science

Collects and records data through observation, interview and experimentation.

Organizes and displays data in table/chart/graph form.

Interprets information displayed in table/chart/graph form:

- personal health/fitness data
- temperature-volume and temperature-pressure relationships
- environmental/pollution factors.

Social Studies

Recognizes the frequent use of polls in the political arena. Analyzes the results of polls.

Organizes and displays gathered data related to provincial, national and global issues.

Occupational Courses

Reads and interprets graphs depicting trends in business and industry (e.g., job opportunities, production cycles, profits and losses).

Reads and interprets tables, charts and graphs in order to perform required tasks:

- engine performance graphs
- oven temperature conversion charts
- charts of body measurement/pattern size
- tap and die charts
- threading charts.

Reads and interprets symbols provided in table or chart form (e.g., hazardous and non-hazardous materials, road signs, fabric care signs).

Suggested Strategies/Activities

Develop learning objectives within the context of themes provided in the *Teacher Resource Manual*. Plan activities throughout each theme that demonstrate:

- how everyday decisions (e.g., decisions about health, employment, finance, sports) are often based on numerical data
- the usefulness of statistics and probability in analyzing numerical data and coping with uncertainty.

Conduct surveys/polls within the local community in order to answer interesting questions that are related to topics investigated within particular themes. As students collect, organize and display information, ask questions that will encourage students to:

- identify potential biases in the data they have collected
- understand the relationship between size of sample and degree of certainty
- draw logical conclusions/make predications that are based upon the numerical data collected
- identify characteristics of the display that may be misleading
- determine appropriate measures of central tendency.

Charts and graphs often make patterns and relationships more discernible in problem situations. Model the use of tables/charts/graphs as a problem-solving strategy. Provide opportunities for students to use appropriate computer software as an aid to organizing and graphing numerical data in problem situations.

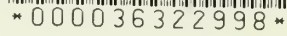
Plan activities that require students to generate, record and interpret data from simple probability experiments, and predict chances of an outcome (e.g., the probability of "heads" in a coin toss; the probability of drawing a "heart" from a standard deck of cards). Use charts, tables and lists to organize all possible outcomes of each experiment.

Identify and demonstrate familiar situations in which:

- the probability or chance of an event occurring is "likely", "unlikely" or "equally likely"
- a game is "fair" or "unfair"
- a particular event/outcome is "impossible" (probability of 0) or "certain" (probability of 1).

Relate the results of investigations on probability to predictions made in "real life" situations (e.g., lottery outcomes, health risks, weather forecasts, election outcomes). Interpret familiar statements of probability made in the newspaper or on television/radio, and discuss their usefulness in predicting possible future outcomes or actions.

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